Shabnum Shaheen · Mushtaq Ahmad
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Edible Wild Plants: An alternative approach to food security

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Mushtaq Ahmad is a plant biologist in the field of biodiversity. He is the author of 387 research publications (to date) in top international journals with more than 3000 citations and high IF, H, and I indices and 20 international books published and circulated internationally. Dr. Ahmad is an awardee of various national and international awards (TWAS, CAS-PIFI, and USEA). He is also an editorial board member of many well-reputed ISI journals and book series. He has supervised 13 Ph.D. and 65 M.Phil. research scholars in applied disciplines of natural plant products, plant biodiversity, wild edible plants, medicinal plants, and energy and environment.

Nidaa Haroon is a Ph.D. scholar in biological sciences. She is a plant scientist and her Ph.D. work is focused on the nutritional evaluation of fodder grasses. Till yet she published ten research articles in national and international journals and is a member of many societies. She is also the author of two international books. Her research interests include nutritional studies, biotechnology, biodiversity, and medicinal plants.

Chapter 1
Food Security: A Global Problem

Food security is a potential predicament to the world at this time. Today we are facing a challenge to provide the inexpensive, sustainable, and nutritious food to the fast-growing world's population.

1.1 Concept of Food Security

Food security is a contrary term to food insecurity. It has a wide range of concept based on the fundamental food issues.

1.1.1 Origin of Food Security Concept

The food insecurity alarm has been rung up when in the 1970s agricultural polices caused changes in world economy and drew attention toward the causes of world food crisis of that particular period. In 1974 for the first time, the World Food Conference held in Rome passed its verdict on this issue [1]:

> ***Every man, woman and child*** *has the inalienable right to be free from hunger and malnutrition in order to develop fully and maintain their physical and mental faculties. Accordingly, the eradication of hunger is a common objective of all the countries of the international community, especially of the developed countries and others in a position to help.*

Later on it was recognized that the issue of world starvation and its related causes are based on a number of different problems with intersecting roots. This problem aggravated during 2007–2008 when a significant rise occurred in world oil prices (more than 100 USD), the use of biofuels, export constraints, procurement with anxiety, and devaluation of US dollar [22–24]. Along with these issues, population

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explosion, sudden climate modulation, industrial revolution, and conversion of agricultural land into residential also reinforced this food security concern [25–28]. Unfortunately no necessary and effective preventive measures have been taken so far, and now these food riots have been spread across the world [2–4].

1.1.2 World Food Summit

The 1996 **World Food Summit** had been held in Rome which aimed to compete against this hunger problem. In response to this widely growing hunger and undernutrition problem, FAO (The Food and Agriculture Organization of the United Nations) called a conference. Two chief documents have been produced by this conference, i.e., the Rome Declaration on World Food Security and the World Food Summit Plan of Action [5, 6].

The Rome Declaration assigned a duty to the United Nations members to prepare a comprehensive list of undernourished individuals on land by 2015. For accomplishment of food security at personal, family, nationwide, and worldwide levels, the Plan of Action has been to propose certain targets for governmental and nongovernmental establishments. Recently another World Summit on Food Security has been dismounted on November 18, 2009 [7, 8].

1.1.3 Probable Definitions of Food Security Concept

It is quite difficult to state precise definition of food security. There are about two hundred (200) definitions and four hundred fifty (450) food security pointers. Some of the more reliable definition has been listed here:

According to 1996 World Food Summit:

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

This definition underlines the significance of accessibility, availability, utilization, and stability in concern to food security. This means that both financial and natural resources and human ability of taking in food in combination determine the food access and its entitlement.

According to WHO (World Health Organization):
The meaning of food security is that:

- All times physical and economic access of all people to gain sufficient food for a healthy and active life.
- Adoption of sustainable and respectful means of food production and distribution.
- Food must be nutritionally satisfactory and also acceptable culturally.

Public Health Association of British Columbia (PHABC) also states about **Community Food Security**:

> *Community food security exists when all citizens obtain a safe, personally acceptable, nutritious diet through a sustainable food system that maximizes healthy choices, community self-reliance and equal access for everyone.*

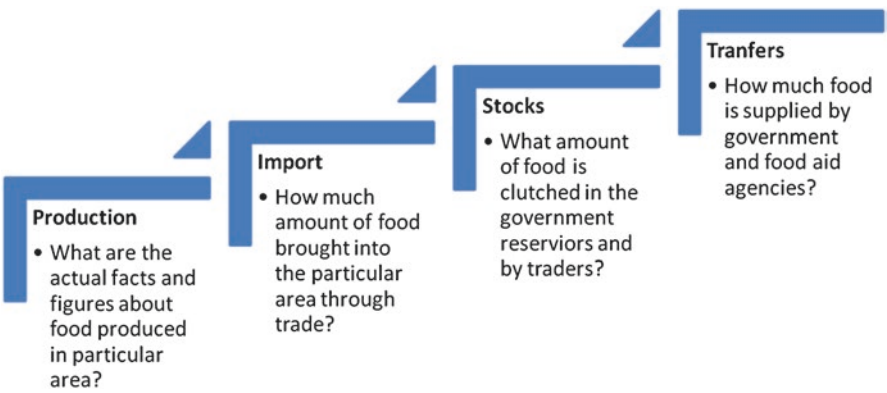
FAO (Food and Agriculture Organization) also restates its vision in this regard in 2007 during the 33rd meeting of the Committee on World Food Security where it was affirmed that:

> *FAO's vision of a world without hunger is one in which most people are able, by themselves, to obtain the food they need for an active and healthy life, and where social safety nets ensure that those who lack resources still get enough to eat.*

All these definitions made this clear that it is the basic right of every person that he or she should have the accesses to appropriate supplies of safe and healthy food of their own choice.

1.1.4 Factors Determining the Food Availability

Food availability is actually the physical existence of food in the particular area by means of all forms: inland production, profitable imports, and food aid. This phenomenon might be aggregated at the community, district, national, or regional level, and it's usually determined by the following factors: [9].



Factors determining food security (REF)

1.2 Ranks of Food Security

Literature states the three levels of food security, i.e.,

(a) Household
(b) Subnational
(c) National

1.2.1 Household Level

At this level food is said to be secure if available food quantity is sufficiently fulfilling the minimum food requirement of all house members, though it could effect by many variables like final production of food, labor, land, social relations, and many others. The following are some examples:

- Private production of crops, livestock, etc.
- Gathering wild foods like fishing and hunting or some wild vegetables
- Buying at markets
- Aids/gifts from some agencies, government, or friends and relatives

1.2.2 Subnational Level

This denotes to the guarantee that sufficient food is available to meet the nutritional and consumption demand of each family.

1.2.3 National Level

This refers to those satisfactory food productions and imports at state level [10].

Categories of food security set by the **United States Department of Agriculture** [11, 12]:

Broad category	USDA category	Description
Food secure	High food security	No reports for problems and limitations in food accessing
	Marginal food security	One or two reports found
Food insecure	Low food security	Reports of lessen food quality, diversity, or attractiveness of diet
	Very food security	Multiple reports about interrupted eating patterns and decreased food intake

1.3 Food Security Pillars

WHO stated the three key pillars of food security, i.e., availability, access, and utilization or consumption; however later on FAO included a fourth pillar of stability into these [13].

1.3.1 Availability of Food

This covers the calculation aspect about food demand and supply. It gives estimation that either available food in any particular region is adequate to nourish the total number of inhabitants. It not only analyzes this from native agricultural production of specific area but also calculates the available levels of stock and net import and export records. Assessment at this pillar will include rainfall records, survey of food markets, food balance sheet, and also agricultural sphere. Multiple indicators for this pillar at various levels are fertility proportion, food yield, population drifts, time of harvesting, production of staple food, food storage, etc.

1.3.2 Access of Individuals to the Available Food

For any country it is not a food security guarantee that they have sufficient food for their inhabitants. Access of individuals to the available food is another dimension of food security, and this involves revenues, procurement size of indigenous people, and expenditures as well. It simply means that whether people of that particular state have ample assets to obtain apposite size of valuable foods. This pillar can be checked by utilizing different indicators at various levels, i.e., food rate, food consumption of each person, frequency of meal, salaries, and degree of population employment. This can be evaluated by conducting food access survey, VAM (Vulnerability Analysis and Mapping), and food focus group discussions [14, 15].

1.3.3 Food Consumption

This not only deals with quantity of food eaten by people but also states about the type and pattern of eating habits. Foods manufacturing, within house distribution of food, hygiene, and healthcare measures are also covered in this dimension. Nutritional profile of a person can only be optimized if consumed food includes diversity, cooked appropriately and fed with a suitable design which poses good health effects. Latrine usage, diarrheal preventive measures, individual age-specific body weight, stunting, and wasting rate are the index at various stages of this pillar.

Immunization charts, demography, and health surveys could be assessment tools of this dimension.

1.3.4 Food Stability

This actually addresses the constancy of the three discussed pillars or dimensions within specific time period. Food cannot be considered secured until or unless steadiness is achieved in circumstances of food availability, accessibility, and consumption. Inflation in staple food rate, joblessness, and poor risk-bearing capacity of individuals due to any natural catastrophe or political imbalance are the key food stability-influencing factors which ultimately affect the food security. Food price instability, pre- and postharvest food rates, migration of local inhabitants, etc. are the certain indicators for assessment of this dimension through anthropometric survey, Global Information and Early Warning System, and weighing chart of pregnant women [13].

Overall, we can summarize that food availability ensures about the prepared food for community, while food access guarantees about the individual resources to attain the available food and consumption deals with necessary amount and type of food for proper human health. However stability gives the assurance to the consistency of already mentioned food security pillars [16].

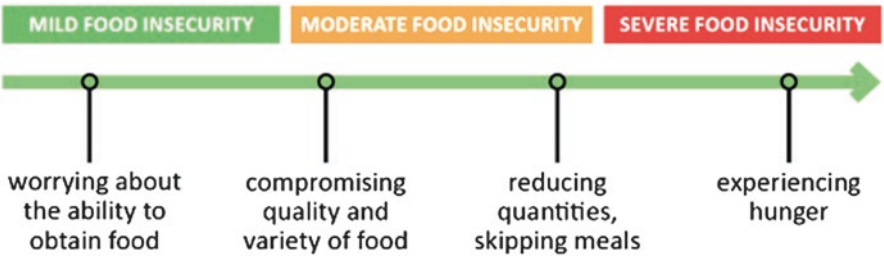
1.4 Difference Between Food Security and Nutrition Security

The food security and nutrition security are undoubtedly closely linked to each other, but yet they have differences. The world has agreed that food security is basic but it doesn't necessarily provide you nutritional security. But these two terms cannot be separated from each other because both of them are part of each other. All proposed definitions of food security are applicable for nutrition security only if households are consuming food up to their dietary requirements. Definitely to achieve a nutrition security, we have to achieve food security first. There is no

possibility to achieve nutrition security without achieving the food security. However nutrition insecurity may increase the threat of food insecurity. Both of these are interrelated and may appear in a spiteful cycle but with different degrees. For instance, when contagious diseases spread in an area because of malnutrition, then to focus on the food security will not be effective at all. In that case nutrition security has to be ensured. Similarly there is no role of health sector in ensuring the food security. However sometimes food security is achieved in a particular area, but nutrition security will require more time and efforts to be set out.

1.4.1 Food Insecurity

Food insecurity is termed as circumstances in the absence of food security. This phenomenon stretches from famine to periodic starvation and leads to indeterminate supply of food.



1.4.2 Food Insecurity Categories

There are two main types of food insecurity.

(a) **Chronic Food Insecurity**
Due to prolonged poverty and insufficient financial resources, least food necessities become unavailable to the people for a constant period of time. This is known as chronic food insecurity. It can be overcome by developing some tools which can address to poverty. These tools could be education, money resources, or some technical learning.

(b) **Transitory (Acute) Food Insecurity**
Certain factors like yearly variations in food values and family incomes can cause short-term fluctuation in food availability and ultimately induce transitory food insecurity. This could lead to extreme cases of hunger if caused by war, flooding, drought, low crop productivity, and pest attack. These situations can trigger food crises at big level. This is unpredictable so effective emergency planning must be required in this situation.

There is another category in food insecurity, i.e., seasonal food insecurity. This type of insecurity lies in between the chronic and transitory insecurities. It is more like chronic food insecurity because it is expectable for that particular season. However sometimes it could become transitory food insecurity is its recurrent itself unevenly and in unpredictable manner.

1.4.3 Expression of Food Insecurity

Food insecurity expresses itself in the following three different ways or groups:

(a) People are facing chronic food insecurity at most extreme levels.
(b) Many people who are living on 1.25 USD/day are vulnerable to acute food crises like civil war, natural catastrophe, and politically executed famine.
(c) The third and last group consists of women or children who unfortunately are forced to live on nutrient-deficient diet that resulted in physical and mental retardation and increases their susceptibility to disease.

1.4.4 How to Measure the Severity in Food Insecurity?

While evaluating the food insecurity, it is not sufficient to know the length of problem that inhabitants are facing, but it is also essential to quantify the intensity and severity of its impact on nutrition status. This data will be influenced by the nature, extent, and perseverance required by the affected people. There are multiple kinds of benchmarks that have been set up used as indicators to measure the severity in food insecurity. The following are some indicators set by the Integrated Food Security Phase Classification (IPC) [17, 18].

IPC Phase Classification	Indicators
Generally food secure	- Crude Mortality Rate - Malnutrition prevalence - Food Access/ Availability - Dietary Diversity - Water Access/Availability - Coping strategies - Livelihood Assets
Chronically food insecure	
Acute food and livelihood crisis	
Humanitarian emergency	
Famine / humanitarian catastrophe	

Source: www.ipcinfo.org

1.4.5 Integrated Food Security Phase Classification (IPC)

The Integrated Food Security Phase Classification (IPC) is an apparatus to classify the severity of food insecurity found on a range of livelihood needs. This is a homogeneous framework for situation analysis expressed in a scale that integrates food security, nutrition, and livelihood-related information into a clear statement of food security status [19–21].

Objectives of IPC

- Provide technical harmony and a common language for categorizing severity and reasons of food insecurity circumstances.
- Promote transparency about food security state through evidence-based investigation.
- Interconnect about the food security situation to decision bodies.
- Provide basis for current and early warning projections.

There are four components of the IPC:

1. Reference table
2. Analysis template
3. Cartographic protocols
4. Population table

This system classifies food security/insecurity into five different phases (Fig. 3) by analyzing:

- Crude mortality rate
- Acute malnutrition
- Disease and food access/availability
- Dietary diversity
- Water access/availability
- Destitution and displacement
- Civil security, coping, and livelihood assets

IPC Phase Classification	
1 (A & B)	Generally food secure
2	Moderately / Borderline Food Insecure
3	Acute Food and Livelihood Crisis
4	Humanitarian Emergency
5	Famine / Humanitarian Catastrophe

Phases of food security according to IPC

1.5 Who Is in Actual Facing the Problem of Food Insecurity?

According to USDA data, 14.5% of households in America were food insecure, and out this 14.5%, 5.4% were categorized in the range of low food security. It is more difficult to measure the food insecurity at global level. According to FAO report in 1999, over 1.2 billion people were facing the chronic food insecurity. Asia was leading with the highest number of food-insecure people, i.e., 642 million at that time, and 15 million undernourished reported in developed countries [29].

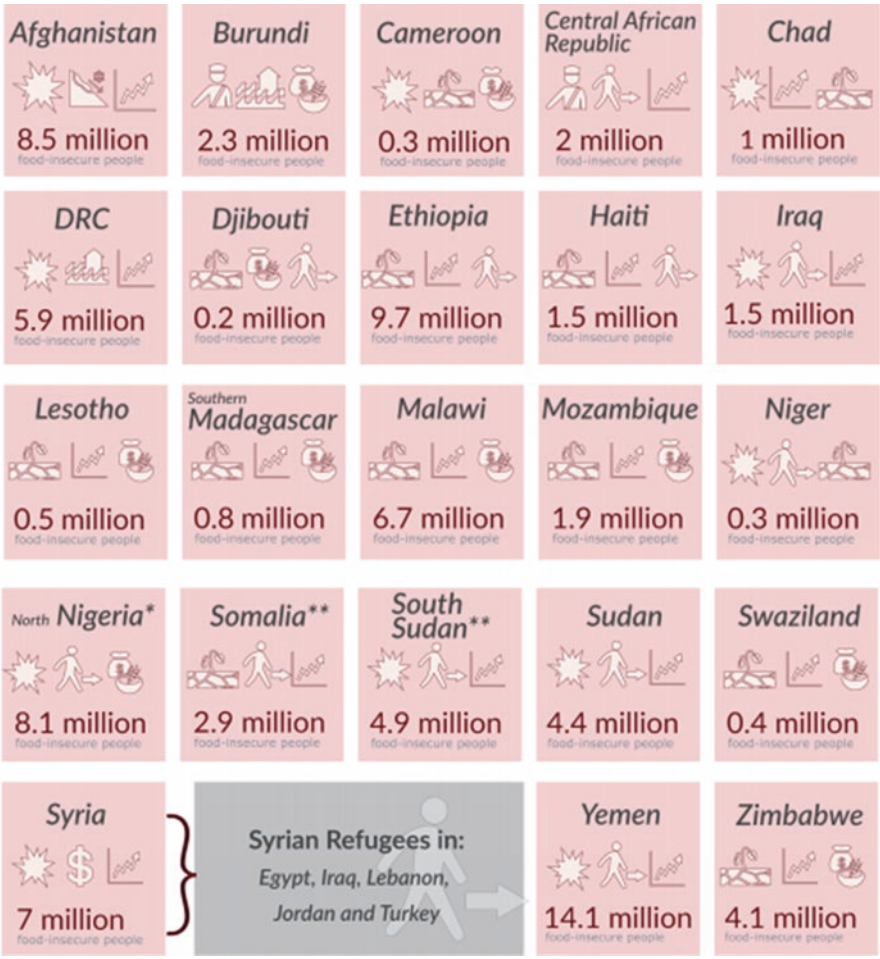
Certain groups of people are more susceptible to food insecurity issue like women who are pregnant or lactating but earning low income, war or conflict victims, refugees, low-income urban inhabitants, aged people (not capable to work anymore), and children below 5 years old as well.

1.6 Why Food Security Is Termed as a Chief Global Challenge?

It is very obvious that food is demanded by every living being. However the complications in supply of sufficient food not only at national level but at global level show that food security is the priority for all countries around the world either developed or underdeveloped country.

Think about India which holds the second position in producing fruits and vegetables in the world. However still FAO stated that 194 million Indians are not getting their required nourishment and 15.2% of population is undernourished to threaten levels that cannot live standard life. Furthermore one third of undernourished children of the world belong to India [30].

In short, we can say it is a global challenge because it is not only a matter of food and nourishing people but also about basically all characteristics of an economy and society.



Countries with food crisis.

Source: Global report on food crises 2017

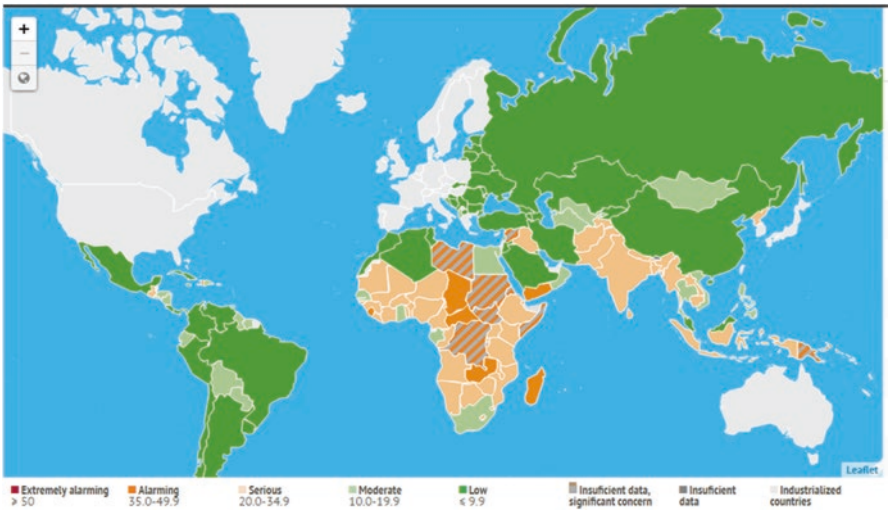
1.7 Global Hunger Index (GHI) 2016

GHI is a tool which is effectively used to estimate the hunger percentages at global, regional, and country altitudes. It is the responsibility of the International Food Policy Research Institute (IFPRI) to calculate the GHI every year around the globe to evaluate their progress and limitations in fighting against hunger. It is the basic goal of GHI to nurture the awareness against hunger so that a systematic approach could be used in order to eradicate this issue [31].

The GHI of 2016 showed that the developing world countries are still combating against this issue. Although they have shown remarkable improvement by decreasing the hunger levels up to 29%, this was an irregular progress, and great inequalities in hunger are still persisting at local, national, and subnational ranks. However 50 countries still have the alarming situations. It is evident from the data that peak hunger levels are in Africa South of Sahara and South Asia [32].

GHI 2016 actually highlights the regions, countries, and nations which are under the threat of hunger and malnutrition so that the world's attention can be drawn to these areas and progress can be accelerated at much higher rate. In order to reveal the multidimensional aspects of hunger, the GHI now syndicates the following element indicators into one index:

1. **Undernourishment:**
   How much population is taking insufficient caloric intake? Express them in terms of percentage.
2. **Child wasting:**
   What proportions of children are at the age of 5 but underweight and under nutritional level?
3. **Child stunting:**
   How many of the children below 5 years old are suffering from stunted growth because of undernutrition issue?
4. **Child mortality:**
   What is the mortality rate of children below 5 years old because of undernutrition?



Source: IFPRI GHI report 2016

Country	Proportion of undernourished in population (%)	Prevalence of wasting in children below 5 years old (%)	Prevalence of stunting in children below 5 years old (%)	Mortality rate of children below 5 years old (%)	Score
Afghanistan	26.8	9.5	40.9	9.1	34.8
Albania	8.5*	6*	15.7*	1.4	11.9
Algeria	2.9*	4.1	11.7	2.6	8.7
Angola	14.2	7.2*	33.5*	15.7	32.8
Argentina	0.2*	1.6*	8.1*	1.3	<5
Armenia	5.8	3.3*	12.9*	1.4	8.7
Azerbaijan	1.7*	3.1	18	3.2	9.8
Bahrain	–	5.2*	9*	0.6	–
Bangladesh	16.4	14.3	36.4	3.8	27.1
Belarus	0.8*	2.2*	3.7*	0.5	<5
Benin	7.5	4.5	34	10	23.2
Bhutan	–	4.4*	26.9*	3.3	–
Bolivia	15.9	1.6	18.1	3.8	15.4
Bosnia and Herzegovina	0.9*	2.3	8.9	0.5	<5
Botswana	24.1	5.8*	23.2*	4.4	23
Brazil	1.6*	1.6*	6.1*	1.6	<5
Bulgaria	9*	3.2*	7.5*	1	8.3
Burkina Faso	20.7	10.9	32.9	8.9	31
Burundi	–	6.1	57.5	8.2	–
Cambodia	14.2	9.6	32.4	2.9	21.7
Cameroon	9.9	5.2	31.7	8.8	22.9
Central African Republic	47.7	7.4	40.7	13	46.1
Chad	34.4	13	39.9	13.9	44.3

(continued)

(continued)

Country	Proportion of undernourished in population (%)	Prevalence of wasting in children below 5 years old (%)	Prevalence of stunting in children below 5 years old (%)	Mortality rate of children below 5 years old (%)	Score
Chile	2.5*	0.3	1.8	0.8	<5
China	9.3	2.1*	6.8*	1.1	7.7
Colombia	8.8	1*	11.5*	1.6	8.5
Comoros	–	11.1	32.1	7.4	–
Congo, Dem. Rep.	–	8.1	42.6	9.8	–
Congo, Rep.	30.5	8.2	21.2	4.5	26.6
Costa Rica	3.8*	1.1*	3.5*	1	<5
Croatia	2.5*	1.2*	1.1*	0.4	<5
Cuba	0.8*	2.1*	4.9*	0.6	<5
Côte d'Ivoire	13.3	7.6	29.6	9.3	25.7
Djibouti	15.9	21.5	33.5	6.5	32.7
Dominican Republic	12.3	2.4	7.1	3.1	11.1
Ecuador	10.9	2.3	25.2	2.2	13.9
Egypt, Arab Rep.	1.9*	9.5	22.3	2.4	13.7
El Salvador	12.4	2	14	1.7	11.2
Eritrea	–	12.5*	49.1*	4.7	–
Estonia	2*	2.6*	3.2*	0.3	<5
Ethiopia	32	8.7	40.4	5.9	33.4
Fiji	4.5*	6.6*	3.7*	2.2	8.5
Gabon	2.7*	3.4	17.5	5.1	12
Gambia, The	5.3	11.1	25	6.9	20.9
Georgia	7.4	2.4*	10.9*	1.2	8.2

Ghana	2.3*	4.7	18.7	6.2	13.9
Guatemala	15.6	0.7	46.5	2.9	20.7
Guinea	16.4	7.8	33.5	9.4	28.1
Guinea-Bissau	20.7	6	27.6	9.3	27.4
Guyana	10.6	6.4	12	3.9	14.5
Haiti	53.4	5.2	21.9	6.9	36.9
Honduras	12.2	1.4	22.7	2	13.2
India	15.2	15.1	38.7	4.8	28.5
Indonesia	7.6	13.5	36.4	2.7	21.9
Iran, Islamic Rep.	3.2*	4	6.8	1.6	6.7
Iraq	22.8	7.4	22.6	3.2	22
Jamaica	8.1	3	5.7	1.6	7.9
Jordan	1.8*	2.4	7.8	1.8	5.7
Kazakhstan	2.5*	4.1	13.1	1.4	7.8
Kenya	21.2	4	26	4.9	21.9
Kuwait	3.1*	2.4	5.8	0.9	<5
Kyrgyz Republic	6	2.8	12.9	2.1	9.1
Lao PDR	18.5	6.4	43.8	6.7	28.1
Latvia	1.4*	2.4*	3.2*	0.8	<5
Lebanon	3*	4*	12*	0.8	7.1
Lesotho	11.2	2.8	33.2	9	22.7
Liberia	31.9	5.6	32.1	7	30.7
Libya	–	6.4*	23.3*	1.3	–
Lithuania	1.4*	2.4*	3.1*	0.5	<5

(continued)

(continued)

Country	Proportion of undernourished in population (%)	Prevalence of wasting in children below 5 years old (%)	Prevalence of stunting in children below 5 years old (%)	Mortality rate of children below 5 years old (%)	Score
Macedonia, FYR	2.4*	4.3	7.7	0.6	5.8
Madagascar	33	9.5*	48.6*	5	35.4
Malawi	20.7	3.8	42.4	6.4	26.9
Malaysia	2*	10.2*	10.8*	0.7	9.7
Mali	4.1*	11.6*	37.7*	11.5	28.1
Mauritania	5.6	11.6	22	8.5	22.1
Mauritius	4.9*	13.3*	10.2*	1.4	13.2
Mexico	4.3*	1.6	13.6	1.3	7.2
Moldova	12.2*	1.9	6.4	1.6	9.2
Mongolia	20.5	1	10.8	2.2	13.8
Montenegro	0.3*	2.8	9.4	0.5	<5
Morocco	4.4*	2.3	14.9	2.8	9.3
Mozambique	25.3	6.1	43.1	7.9	31.7
Myanmar	14.2	7.1*	31*	5	22
Namibia	42.3	7.1	23.1	4.5	31.4
Nepal	7.8	11.3	37.4	3.6	21.9
Nicaragua	16.6	1.1*	15.5*	2.2	13.3
Niger	9.5	18.7	43	9.6	33.7
Nigeria	7	7.9	32.9	10.9	25.5
North Korea	41.6	4	27.9	2.5	28.6
Oman	4.1*	7.5	14.1	1.2	10.4
Pakistan	22	10.5	45	8.1	33.4
Panama	9.5	0.9*	13.6*	1.7	9.3

Papua New Guinea	–	14.3	49.5	5.7	–
Paraguay	10.4	2.6	10.9	2.1	10.4
Peru	7.5	0.6	14.6	1.7	8.6
Philippines	13.5	7.9	30.3	2.8	19.9
Qatar	–	2*	1*	0.8	–
Romania	0.8*	3.3*	9.5*	1.1	5.5
Russian Federation	0.7*	4.5*	12.8*	1	6.8
Rwanda	31.6	2.2	37.9	4.2	27.4
Saudi Arabia	1.2*	3.6*	3.4*	1.5	<5
Senegal	10	5.8	19.4	4.7	16.5
Serbia	6.9*	3.9	6	0.7	7.1
Sierra Leone	22.3	9.4	37.9	12	35
Slovak Republic	4.8*	2.9*	4.2*	0.7	5.3
Somalia	–	–	–	13.7	–
South Africa	1.7*	3.4*	22.2*	4.1	11.8
South Sudan	–	23.8*	33.7*	9.3	–
Sri Lanka	22	21.4	14.7	1	25.5
Sudan	–	16.3	38.2	7	–
Suriname	8	4.9*	8.6*	2.1	10.1
Swaziland	26.8	2	25.5	6.1	24.2
Syrian Arab Republic	–	–	–	1.3	–
Tajikistan	33.2	9.9	26.8	4.5	30
Tanzania	32.1	3.8	34.7	4.9	28.4

(continued)

(continued)

Country	Proportion of undernourished in population (%)	Prevalence of wasting in children below 5 years old (%)	Prevalence of stunting in children below 5 years old (%)	Mortality rate of children below 5 years old (%)	Score
Thailand	7.4	6.7	16.3	1.2	11.8
Timor-Leste	26.9	11	50.2	5.3	34.3
Togo	11.4	6.7	27.5	7.8	22.4
Trinidad and Tobago	7.4	4.7*	3.6*	2	8.5
Tunisia	0.4*	2.8	10.1	1.4	5.5
Turkey	0.2*	1.7	9.5	1.4	<5
Turkmenistan	3.2*	5.5*	12.9*	5.1	12.3
Uganda	25.5	4.3	34.2	5.5	26.4
Ukraine	1.2*	1.6*	7.6*	0.9	<5
Uruguay	3.3*	1.3	10.7	1	5.6
Uzbekistan	4.2*	5.8*	18.7*	3.9	13.1
Venezuela, RB	1.3*	3.5*	12.8*	1.5	7
Vietnam	11	5.7	19.4	2.2	14.5
Yemen, Rep.	26.1	16.2	46.8	4.2	35
Zambia	47.8	6.3	40	6.4	39
Zimbabwe	33.4	3.2	26.8	7.1	28.8

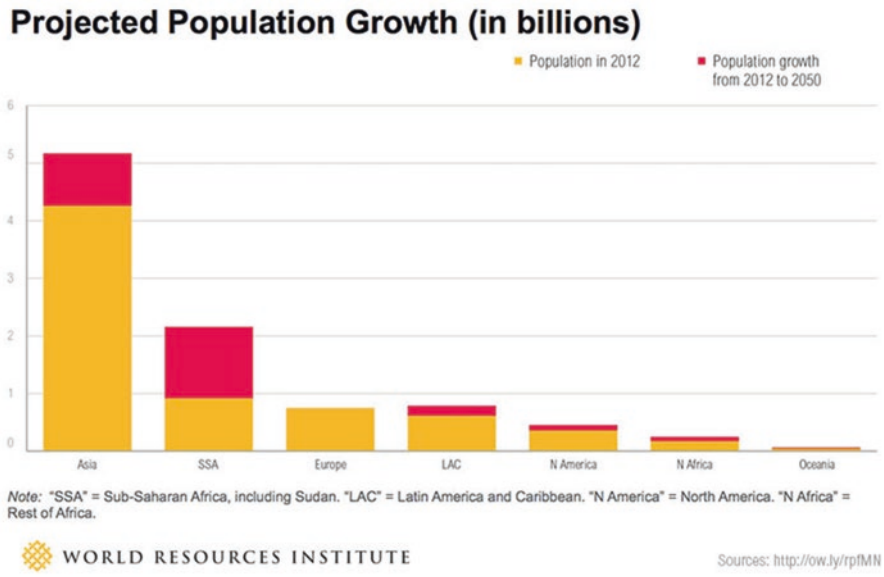
Source: IFPRI GHI Report 2016
*stands for IFPRI estimates
– data not available or not presented

1.8 Challenges to Food Security

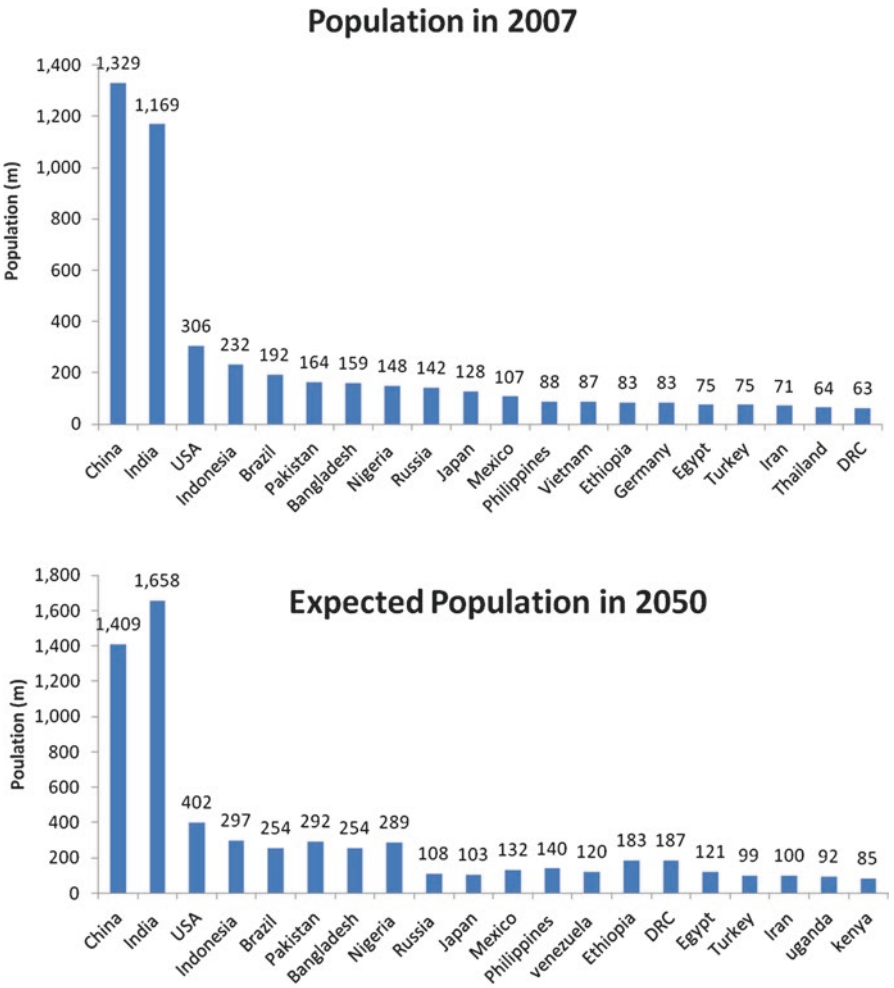
The agricultural revolution of advanced countries (after the Second World War) and green revolution of developing countries transformed the routine agricultural practices in the mid-1960s. This revolution dramatically elevated the crop production; however some limiting factors severely affect it by the time and did not satisfy the probable world food demand (FAO: How to feed the world in 2050). A diverse kind of factor affecting the food security and these factors could be internal or external. Some major challenges to food security have been listed.

1.8.1 Mounting Population

According to a report, the global population will reach to statistics of nine billion by 2050, which is 6.8 billion greater than from current population numbers. This value varies from country to country as well. For example, Africa is expected to increase its population twofold (from one to two billion) by 2050. The increasing population also significantly reinforced the food demand (Cabinet Office: Food Matters: Towards a Strategy for the 21st Century). Not only this increasing population but also the urbanization in developing countries is the major threat to food security [33].



Source: UN Department of Economics and Social Affairs (2006)



Source: UN department of economics and social affairs (2006)

1.8.2 Growing Incomes Influence the Diets

As the country progresses in its economy, it also positively affects the incomes of its nation. However because of the increase in income, people more tend to move for westernized diets. As the income of people increases, they start consuming grain, livestock, and poultry products with much higher frequency.

Global Consumption of Meat and Milk Products

REGION	LIVESTOCK (KCAL/PERSON/DAY)			BEEF AND MUTTON (KCAL/PERSON/DAY)		
	2006	2050	% CHANGE	2006	2050	% CHANGE
European Union	864	925	7%	80	75	-6%
Canada & USA	907	887	-2%	117	95	-19%
China	561	820	46%	41	89	116%
Brazil	606	803	33%	151	173	15%
Former Soviet Union	601	768	28%	118	156	32%
Other OECD	529	674	27%	64	84	31%
Latin America (ex. Brazil)	475	628	32%	59	86	45%
Middle East and North Africa	303	416	37%	59	86	45%
Asia (ex. China, India)	233	400	72%	24	43	79%
India	184	357	94%	8	19	138%
Sub-Saharan Africa	144	185	29%	41	51	26%
World	**413**	**506**	**23%**	**50**	**65**	**30%**

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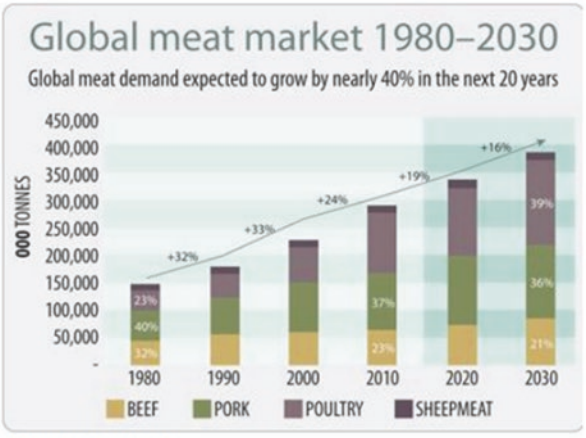
Sources: http://ow.ly/rpfMN



Graph: Rabobank

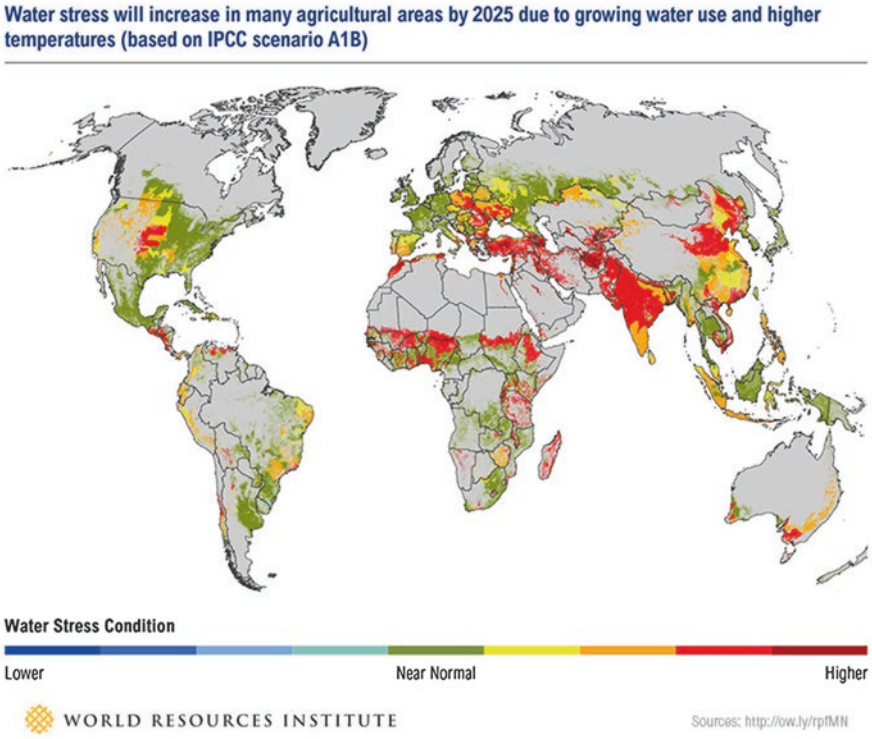
1.8.2.1 Low Water Tables

About 190 million in India and 130 million people in China are being nourished with the food that is produced by groundwater over pumping. This heavy pumping pressure causes the lowering of groundwater tables which directly influence the crop yield. The problem is severe in China and India; however it's prevailing in Afghanistan, Algeria, Egypt, Mexico, Iran, and Pakistan as well. At regional level sub-Saharan Africa is most likely under the threat of water shortage. Among 800

million inhabitants of Africa, 300 million are suffering from water stress issue [34]. As the majority of Africans rely on agriculture for their living, therefore loss of water will lead to loss of food security for 80–90% of rural African families [35].

1.8.2.2 Slow Irrigation

The principal limiting factor in increase of food yield is the short water supply. The irrigation area has been expanded from 250 million acres to 700 million since 1950–2000. This seems to be a great achievement, but between 2000 and 2010, this expansion has seemed to be halted as it remained to only 10% [15].



1.8.2.3 Rapid Soil Erosion

Approximately third of the world's harvesting land is trailing its topsoil faster than the new forming soil. This activity influences the fertility of land and also threatened the future crop production. Forty percent of world agronomic land is badly degraded [35]. UNU's Ghana-based Institute for Natural Resources in Africa

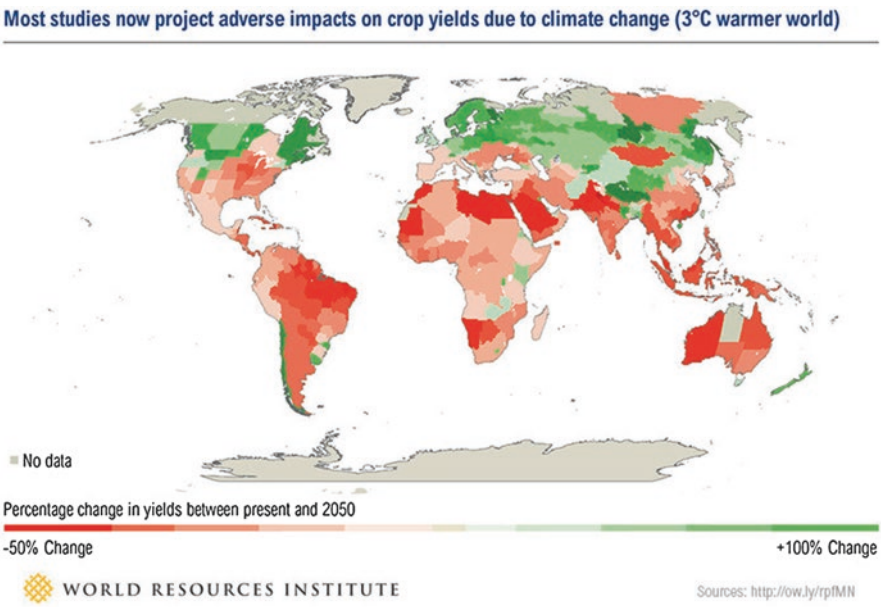
claimed that if current soil erosion does not stop, then in 2050, Africa would be able to feed only 25% of its people [36].

1.8.2.4 Climate Change

Increasing global heat is playing a role in altering the nature's balance, at commencement affecting the water reservoirs and supplies and forest resource, and ultimately leading to effect on crop yield as well. According to the report of Climate and Development Knowledge Network *Managing Climate Extremes and Disasters in the Agriculture Sectors: Lessons from the IPCC* SREX, change in productivity and living designs, economic fatalities, and food security will be the probable effects of sudden climate change.

The main causes are abundant burning of fossil fuels, the use of aerosol, and deforestation. Moreover the intensive agricultural practices are also contributing in methane gas production. Increasing world temperature will subsequently increase the desertification process around the world. Currently only 40% of land is arid, but escalating temperatures will lead to earth's desertification. Droughts will increase especially in North America, Australia, and Africa and may also aggravate issues of flooding in South America and Indonesia. Insect and pest activity will also be enhanced though this global warming process will directly affect the agricultural yield. It is estimated that in 2050 only half of the world population will be fed by food we are producing today.

Tomas Castelazo where climate change increases desertification



This climate change affects all dimensions of food security: availability, accessibility, utilization, and its stability as well.

1.8.2.5 Melting of Glaciers

In the Andes, the Alps and the rocky mountain glaciers are melting with more speed as compared to the past years, but irregular melting of Himalayas and Tibetan plateau glaciers are more severely affecting the major agricultural areas of world. These rivers actually withstand in dry seasons by melting of ice caps. In many river basins like Indus, Ganges, Yangtze, and Yellow, agricultural irrigation chiefly relies on these rivers. Along with these, Pakistan, India, China, Bangladesh, Afghanistan, and Nepal are in threat of floods trailed by droughts in forthcoming decades [37]. The western coast of North America which mainly depends upon glaciers for its water would be severely affected by this issue [38]. Not only are these melting glaciers the alarming threat but also the rising sea level causing sinking of available agriculture land [39, 40]. Therefore the irrational loss of glaciers wills consequence in water shortage for harvesting and could generate incontrollable food scarcities.

1.8.2.6 Land Access

One of the main obstacles in ensuring sustainable agriculture is the poorly developed land tenure system. Usually farmers are forced to grow export-oriented products, and this encourages the migration of rural people to urban areas. About half of the world's food is coming from 40 million small farms which are not bigger than

two hectares. These small farms are producing for their own food and for market share as well. This kind of system would never enable the people to be self-reliant and grow commercially, and these people who are directly or indirectly related to farms are contributing three quarters of global hunger.

1.8.2.7 Less Female Share in Agriculture

Most of the women are working in agriculture farms as unpaid or less paid workers. They are playing an important role as farmer, in managing livestock and in fish farming as well, but still their role significantly differs by area to area. In developing countries they are 43% of the agricultural labor force. They have different agricultural roles but have to face more constraints than men in retrieving the reliable resources, markets, and services. This gender discrimination lowers down their moral and contribution in agricultural sector. This will ultimately lead to their poverty, especially for single mothers.

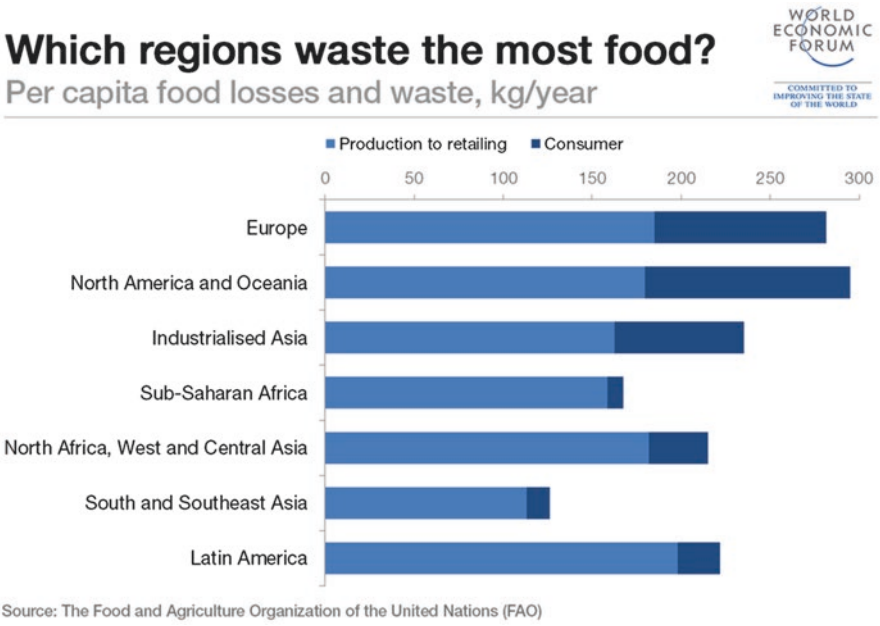
1.8.2.8 Pestilence

It has been estimated that nearly 25% of crops can be damaged by the invading of pests and other diseases, e.g., fungi, insects, and other pathogens (6ftp://ftp.fao.org/docrep/fao/011/ai480e/ai480e00.pdf). The most notorious fungal disease *rust* is the most predominant threat to rice and wheat. It is estimated that Ug99, a wheat stem rust family, is persistently found in wheat lands of Africa and Middle East countries. This lineage has potential to damage 100% crop and would affect food security universally [41, 42].

In 2009 a terror of regional food crisis has been raised when a new species of caterpillar invaded Liberia and also spread to neighboring Guinea. This caterpillar hit 65 towns of Liberia, and 20,000 people left their native town because there was no food to eat. Later on this was identified as *Achaea catocaloides* which lives and feeds on Dahoma tree, has the capability to grow in greater number, and can affect the agricultural lands [7, 8]. Another weed name as *Striga* is capable of producing 50,000 seeds with the 20 years of viability. These seeds remain in agricultural land, and upon germination time they start competing with crops for available nutrients [10].

1.8.2.9 Waste

In developing countries 37% harvested food can be lost before its consumption because of inadequate processing, storing, and transporting means. The rough estimation of rice loss states 10–25% in Vietnam and 5–23% loss in China. A report on food waste in the United States showed that 43 billion kg of food is used and lost during trading process (Disappearing food: How big are postharvest losses?). Similar losses have been recorded in the United Kingdom as well where 4.4 M apples, 1.6 M bananas, 2.8 M tomatoes, and 5.1 M potatoes are thrown away [43].



1.8.2.10 Insufficient Food Processing

The direct processing of food avoids the food to be wasted and can be more easily stored for the later consumptions. A good example for food transformation is the conversion of fruits into juices. In the figure below, the heap of oranges in local markets of Edo state is shown, and due to lack of sufficient processing techniques and equipment, a lot amount is going to be wasted [44].

Food security needs adequate food processing technique to avoid wastage.

Source: New Benin market, Benin City; 2009

1.8.2.11 Lack of Sustainable Agricultural System

In recent times several efforts are being made to increase the significant food production. However it has been criticized those contemporary agricultural practices are deficient of sustainability content. The crop yield is actually augmented on the cost of oil-based fertilizers elevating the expense of crop production. Moreover huge energy inputs are also required for agrochemicals and irrigation systems. In spite of their cost issue, these modern techniques play a catalyst role in altering the climate as well.

1.8.2.12 Less Scope as a Farmer

As the country progresses, its people more likely switch to other professions which seemed to them more reputed and profitable. Therefore in developed countries, less than 2% of people are currently associated with agriculture and livestock industry [44]. At the same time, the soil of agriculture countries is in threat to be degraded because of unplanned and over-farming practice. All of these factors in combination contribute in the increase of food prices, and hence increased food prices ultimately become a challenge for food security.

1.8.2.13 Role of Biofuel

According to the confidential World Bank report, the biofuels forced the food prices to rise up to 75%. Now the grain is averted from food to fuel. One third of US corn is now converted to ethanol, and half of the EU vegetable oils are subjected for biodiesel production [45, 46]. These circumstances played a triggering role in raising up the food prices which ultimately contribute to food insecurity. IFPRI (International Food Policy Research Institute) estimated that these biofuels have contributed 30% to raise the food prices. In short biofuels may be liable for some 30–75 million people being compelled into hunger. Following are some facts about this cause: [47].

1.8.2.14 Intrastate Conflicts

In the twentieth century, the nature of conflicts has been changed. It is more common to have intrastate conflicts rather than conflicting with any other country. The saddest thing is that these conflicts are most likely observed in poor parts of the world like Africa and Asia, where food is already insufficient to meet their demand. Studies showed that hunger is surely the consequence of conflict but could also be its cause as well. However whatever the cause of these conflicts like political, economic, cultural, or environmental, and religious factors, all of these will affect the food resources and accessibility of poor to these resources. Internal or external

Table 1.1 World grain production and consumption, 1991–2003 [million T]

Year	Production	Consumption (biofuel generation)	Surplus or Deficit
1991	1.707	1.712	−5
1992	1.788	1.738	50
1993	1.712	1.741	−29
1994	1.756	1.766	−10
1995	1.710	1.747	−37
1996	1.871	1.813	58
1997	1.879	1.825	54
1998	1.875	1.835	40
1999	1.871	1.854	18
2000	1.838	1.855	−16
2001	1.870	1.898	−27
2002	1.819	1.910	−91
2003	1.827	1.932	−105

Source: U.S. Department of Agriculture, Production, Supply & Distribution

conflicts are directly correlated to the food insecurity issue. These not only can destroy the available food resources but indirectly discourages the farming and other money resources.

1.8.2.15 Dictatorship

Amartya Sen (a Nobel Prize winning economist) said that "there is no such thing as an apolitical food problem" [48]. However natural catastrophes (drought and famine) can play triggering role. In reality the actions of the government is solely responsible for the severity of food scarcity problem. There are many incidents in the twentieth century which shows the negligence of governments in food insecurity issue either unintentionally or intentionally. If the government establishes by unfair means, it will lead to the imbalance food distribution within the country. Often the government gives more priority to those areas where most persuasive families and enterprises are placed and usually ignores the needs of underdeveloped remote areas. In worse scenarios politician used food as political weapon and buy people support and vote by using food as a currency [49].

1.9 Critical Consequences of Food Scarcity

The critical consequences of food security include:

1.9.1 Rising Food Prices

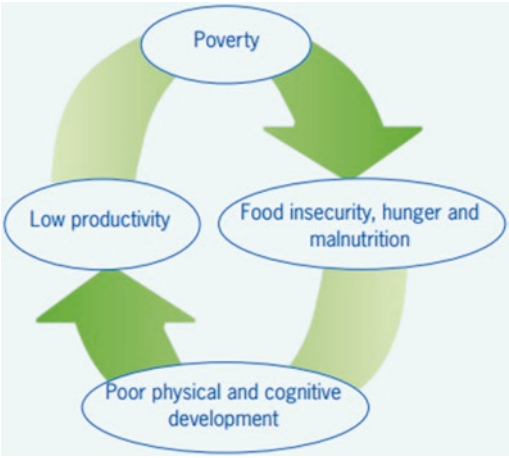
Increasing demand directly affects the cost of food. Especially the prices of staple foods like wheat, rice, and sorghum has been upsurge by 130%, 74%, and 87%, respectively, in across 36 countries (BBC Special Report: the cost of food) [50–52]. These high values of primary foods straightaway affect the common men of developing countries who usually survive on cereal-based diet. This eventually leads to hunger and malnutrition issues which cause greater number of deaths than AIDS, TB, and malaria (World Food Programme: Winning the war on hunger) [53, 54]. According to the International Food Policy Research Institute (IFPRI), there are three main reasons for food price increases:

- Biofuel production
- Commodity trading
- Climate change

Increase in food prices more badly affects the smallholder farmers and underdeveloped countries as compared to massive food producers [55].

Real and nominal food price indices. 1985–2011
(Index numbers, 2000 = 100).

Source: UNCTAD secretariat calculations, based on *UNCTADstat* **Commodity Price Statistics and UN Statistics Division,** *Monthly Bulletin of Statistics*, **various issues**

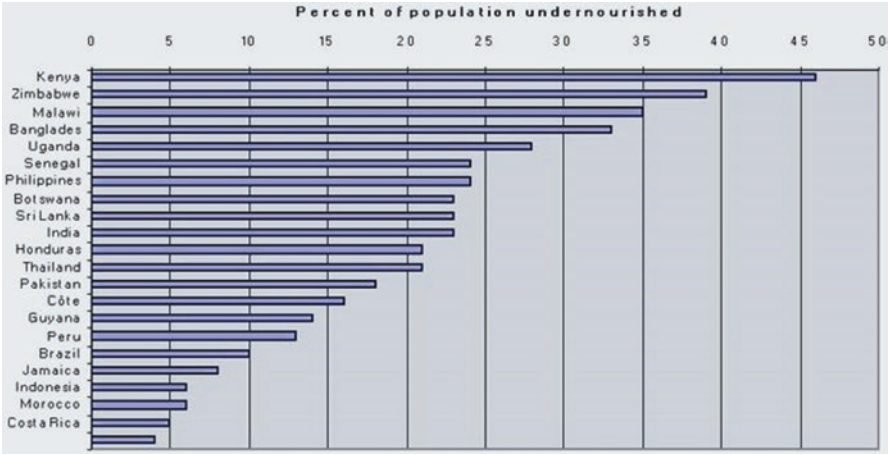


Integration of food security and poverty

1.9.2 Hunger and Malnutrition

Hunger and malnutrition are not exactly the same terms, but eventually hunger usually leads to the malnutrition. Hunger is actually a painful feeling which rose by inadequate food intake. Technically we can say hunger is the food deprivation. This food deprivation ultimately leads to the deficiencies of macro- and micronutrients in the human body. Malnutrition is a consequence of food insecurity. This usually put bad effects on children growth. As the children needed good nutrition particularly in the first 3 growing years of their lives, therefore lack of nutrition will affect their mental as well as physical growth and development. Around the world the food insecurity problem marks critical effects in case of enhancing malnutrition especially in children. Some of the world facts related to malnutrition have been demonstrated in the following figure and table. Instable income state of families badly affects the children health and mental growth. It can reduce the nutrient-sufficient diet which directly affects their education and health which ultimately play a role in lowering down the rate of economic development [56–58].

Most of the undernourished, hungry people live in overpopulated regions of the world, i.e., Asia and Pacific followed by sub-Saharan Africa [59, 60].

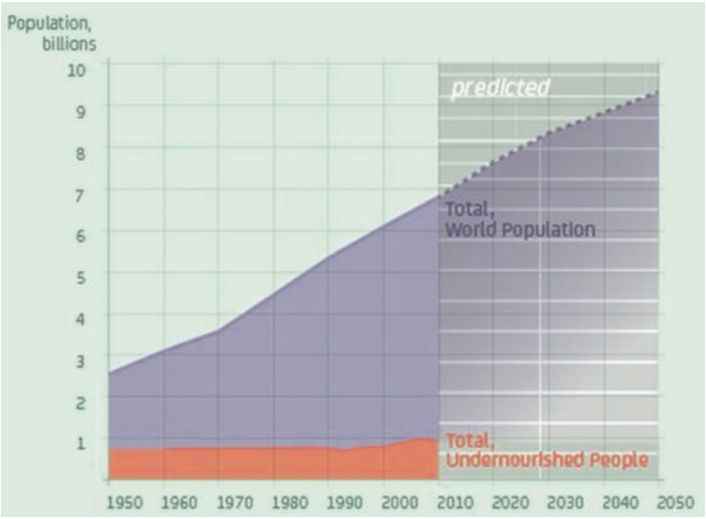


Incidence of undernourishment in some countries.

Source: FAO, State of Food Insecurity in the World 2001

Table 1.2 Statistics about world food and hunger

Sr. #	Reported data	Reporting bodies
1	842 million people around the world do not have sufficient to eat. This number has dropped by 17% since 1990	State of Food Insecurity in the World, FAO, 2013
2	Roughly 100 million (01 out of 06) children in developing countries are underweight	Global Health Observatory, WHO, 2012
3	3.1 million children die each year because of poor nutrition. Approximately half (45%) of deaths in children under age of five	Series on Maternal and Child Nutrition, The Lancet, 2013
4	827 million hungry people live in developing countries, where 14.3% of the inhabitants is undernourished	State of Food Insecurity in the World, FAO, 2013
5	Over 500 million hungry people (the largest number) residing in Asia and sub-Saharan Africa have the highest pervasiveness (24.8% of population)	State of Food Insecurity in the World, FAO, 2013
6	Crossways the developing worlds, 66 million primary school-age children go to their classes while they are hungry, with 23 million in Africa alone	Two Minutes to Learn About School Meals, WFP, 2012
7	According to WFP calculation, US$3.2 billion is required per year to reach all 66 million hungry school-age children	Two Minutes to Learn About School Meals, WFP, 2012
8	One in four of the world's children is stunted and underdeveloped. In developing countries, the percentage can rise to one in three	Prevalence and Trends of Stunting among Children, Public Health Nutrition, 2012
9	80% of the world's stunted children live in just 20 countries	Maternal and Child Undernutrition: Effective Action at National Level, The Lancet, 2008



1.9.3 Disease Prevalence Chances

The long-term food insecurities (chronic) badly affect the health status of those who are facing that. Adults having food insecurity issue probably have low income, and this will lead to depression, obesity, high blood pressure levels, and mental decline among them [61].

Studies showed that diabetic patients with food insecurity issue have less ability to manage their medical disorders, and usually they have stumpy self-confidence in taking maintenance of their own well-being. Similarly the pregnant women who bump into the food insecurity will have a chance to intake less amount of vital nutrients for their babies' health. This condition is prolonged; it can lead to underdeveloped fetal, premature births and underweight baby's birth. This risk will not only become a challenge for the child itself but also put another financial burden to parents. A roughly estimated cost for taking care of underweight baby for the first year is $60,000 [61].

Food insecurity not only destroys the physical and mental health of the child, but it also affects its overall development. Researchers showed that this psychological stress affects the whole future of the child and it directly affects its social behaviors as well. Research showed that food-insecure household's kindergarteners always showed poor progress in comparison to child belonging to food-secure household. There is also risk of anxiety and behavioral disorders to those children who encounter food insecurity in his/her childhood. Even the likelihood of substance abuse is also amplified.

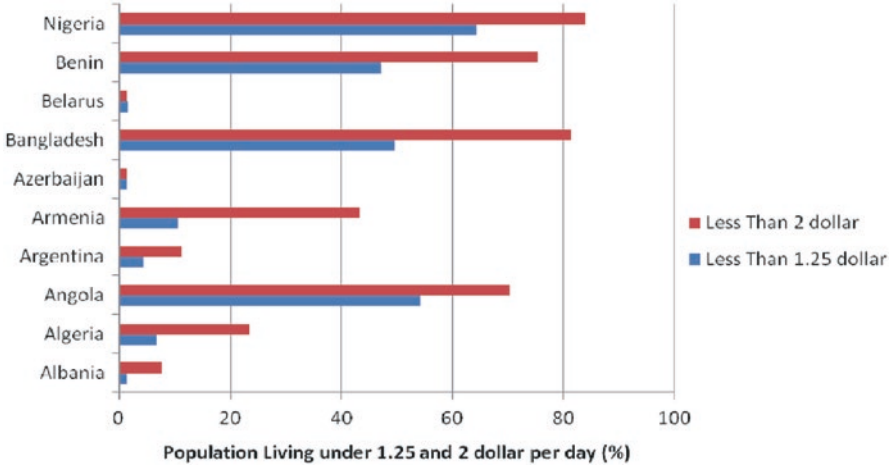
Table 1.3 The higher the low-income percentage, the higher the risk of the disease

Chronic health disorders	Disease rate in entire population (%)	Disease rate in low-income population (%)	Difference
Diabetes	8	22	2.8 × more prevalent
Obesity	26	59	2.3 × more prevalent
Hypertension	24	53	2.2 × more prevalent
Coronary heart disease	6	18	3.0 × more prevalent

Source: National Health Interview Survey, 2007

1.9.4 Threat to Humanity

Starvation, poverty, and disease are interrelated to each other and have occurred as the consequence of unsustainable food supply. Hunger and malnutrition weakened the natural immunity against any disease, and then risk of susceptibility magnifies many folds. Their poverty leads to hunger and hunger lead to sickness, and ultimately the situation becomes worse when they can't work anymore because of the illness issue. This physical and mental crisis also affects their education, social behaviors, and moralities. Many times this whole scenario urged them to theft, steal, or even kill someone to get food means.



List of countries by percentage of population living in poverty

1.9.5 Development Under Threat

If a country is unable to feed its nation, then people will no longer be concerned in working in interest of their country. They will lead their whole life fighting for food, education, and health resources. In this case how will the physically and mentally disabled, nutritionally impaired people construct a progressive nation? Hence in the end, the progress of those world countries will be static without a doubt.

1.10 Possible Solutions to Overcome Food Scarcity

Today the world badly needs concentration and focus on food security agenda. World leaderships should discuss what possible steps should be taken to confront this problem. A collaborative, multinational approach with integration of science and engineering in this area could result in beneficial socioeconomic consequences. Some probable solutions for ensuring food security have been listed.

1.10.1 Development of Government Support Schemes

Government of all nations should develop a sustainable system to identify the level of food insecurity in their countries. It should also make strategic plans for the empowerment of their people so that they can get the basic food requirements for their nourishment.

1.10.2 Employment of Sustainable Agricultural Techniques

There is a need to employ sustainable agricultural practices like employment of leguminous nitrogen fixers (as a soil fertilizer) along with synthetic fertilizers and pesticides which is a way to achieve the environmental sustainability (now for the green revolution). Through this practice not only the risk of pest damage will be reduced but also the production can be enhanced.

1.10.3 Provide Partnerships to Farmers

We can control the world food crises, if we provide partnerships to our farmer to advance entrepreneurial solutions for increase in production and incomes and for sustainable agriculture. We can provide them investment, training, and advance tools through which they can increase their productivity. With more advanced better

technology, the farmer can double his crop production without using more land. There is just a need to crate right conditions and incentives for them.

1.10.4 Need to Improve Financial Status of Individuals

The food insecurity has direct relation to poverty. Therefore there is a need to improve financial status of the population. Stakeholders should make their honest efforts to create more employment and business opportunities in society so that people may fight against food insecurity giant.

1.10.5 Development of Livestock

Livestock is the most important source of nourishment, as it is providing food in the form of milk and meat. This is a contributing factor in increasing food security. The state should provide resident and veterinary services to develop disease-free breed. This industry should be managed and upscaled to meet the world's food demand.

1.10.6 Infrastructure Development

The kind of infrastructure directly affects the food security. Local markets must be well capable to provide and ensure incomes to the people associated with livestock, agricultural, and irrigation business.

1.10.7 Improvement of Irrigation Schemes

It has been discussed that poor irrigation is one of the causes of rising food insecurity in our world. Hence there is a need of time to make proper irrigation strategies by understanding rainfall patterns of particular area. World's food production and availability can be improved by the incorporation of an effective, proficient, and cost-effective irrigation technology.

1.10.8 Development of Resistant Varieties

It is the era of biotechnology which enables us to develop genetically disease-resistant varieties of crops. These resistant crops are capable of self-defense against pathogenic diseases. Through this way we can minimize the crop damage, and ultimately food security can be achieved.

1.10.9 Halt the Spread of Invasive Species

Usually the role of invasive species has been overlooked in assuring food security.

However it is one of the major threats to our agricultural production. Any nonnative species including animals, insects, and weeds are much potentially dangerous to run off massive areas of pastureland, invade crops, and poison or kill livestock, although by taking regular monitoring and risk measures, we can prevent them to invade. But those lands which are already affected by them can be rescued by introducing some natural or biological control means.

1.10.10 Increase the Scope of Agricultural Careers Among Young People

It has already been stated that one of the reasons of this food insecurity is that many young people are no more interested in agriculture. Hence there is a need to reinvigorate their attention to agriculture. Proper agriculture education and training with incentives has to be provided to young people in their local areas so that their agricultural interest can be refreshed and they become a functional unit of effective, efficient, and sustainable food production system.

1.10.11 Ensuring the Contribution of Women in Agriculture

Empowering the women is also a way to safeguard food crises. The only challenge is to overcome their cultural barriers and to approach them in a right way. It is needed to create a proper learning environment for them and subject them to agricultural practice.

1.10.12 Switching to Wild Foods

The documented literature on food security usually emphasizes cultivation of food [54, 55]; however wild edible plants (WEPs) are playing significant role to increase food security. There are only 30,000 plant species that are considered to be edible between 300,000 and 500,000 existing plant species [22]. Among these 30,000 edible plants, we are just focused on 7000 plants for food and cultivation from prehistoric times. The greater alarming fact is that only 20 species are endorsed to 90% of the world to fulfill their food requirements and even among that 60% of man diet is composed of wheat, maize, and rice [23]. So it can be said that around 10,000 edible

plant species are still underutilized and consequently the genetic diversity will start reducing and it will be accompanied by the dislocation of indigenous species by some other more preferred crops [21].

These wild edible plants (WEPs) are capable of spontaneously growing in nature in any type of ecosystem and can maintain its independent existence as well [53]. The available food balances guide strategies (regional and national level) surprisingly not presenting the contribution of wild foods. The repetitive ignorance of wild food significance would result in the loss of indigenous knowledge in support of the utilization of these plants as a food [56–58]. Wild foods have been already incorporated into the diet of around one billion people [59]. People are using them as a source of nutrients and as alternative to staple foods and also to generate their income. Particularly poorer families of rural areas prefer their use where they can aid to lessen spending of inadequate cash resources on energy, lodging, food, and treatment. WEP consumers in critical food shortages are able to expand food sources, alleviate malnutrition, and create alternative revenues. The wild foods are increasingly important during catastrophes like droughts, as well as during famines brought on by market fluctuations, political unrest, and military conflict.

For instance, in Kholagaun village, Nepal, 40% of food is provided by wild sources. Similarly in South Africa, 31% of domestic and wild vegetables are grown in residential plots. Now the knowledge of wild food has not been restricted as only ancient practice, but people are focusing on their transplantation and cultivation. Several other countries like Guatemala, Kenya, and Thailand are also cultivating their wild food resources. These wild foods are not only served to provide nutrition but also have big sale market at local and international levels. For example, in Kenya traditional African leafy vegetables are very much liked by the Nairobi and other related countries.

1.11 World's Efforts in Food Security

1.11.1 Efforts by the United Nations

The UN Millennium Development Goals are one of the initiatives intended to achieve food security in the sphere. According to the first Millennium Development Goal, UN is responsible to eliminate extreme hunger and poverty by 2015 [43]. Multidimensional approach to food security challenges has been suggested by Olivier De Schutter (the UN Special Rapporteur on the Right to Food). Through this approach UN has to ensure:

(a) Availability of food
(b) Affordability of food
(c) Nutritional adequacy of food [44]

1.11.2 Efforts by the FAO (Food and Agriculture Organization)

FAO states that food security can be achieved by focusing on agricultural and economic growth. They proposed twin-track tactic to compete against food insecurity. It actually combines short-term hunger relief and sustainable development. They stated that short-term food security can be achieved by supplying seed and fertilizer vouchers to farmers. However developmental approach includes financing to rural markets and their substructure. Along with these approaches, school feeding programs and alternative food aid approaches are included. Moreover FAO stressed to lower down the food prices. In the 1990s FAO attributed evolution in agricultural yield and macroeconomic constancy that lead to increase in food security. HarvestPlus and the Golden Rice Project are the two programs that work to decrease the micronutrient insufficiencies [45].

1.11.3 USAID Efforts

The USAID (United States Agency for International Development) recommends numerous key steps to aggregate agricultural productivity which is in turn source to increase the rural revenue and plummeting food insecurity [52]. They embrace:

- Enhancing agricultural science and technology
- Locking property rights
- Increasing human wealth through education and better health
- Enhancing human capital through education and improved health
- Governance based on principles of accountability and pellucidity in public institutions

1.11.4 By World Food Programme (WFP)

WFP works in assistance to the United Nations, aimed to endorse food security, and exterminates hunger and poverty issues. The WFP delivers food relief to those who are facing severe food shortage circumstances. It also targeted to provide food with good nutritional quality for healthy living [46].

1.11.5 Worldwide Corporations to Triumph Food Security

A food assistance convention has been signed in 2012, which was the first international food aid agreement. Sustainable development goals have been established which particularly aimed to achieve food security by 2030 [47]. Multiple other

activities and goals have been set globally to attain the aim of universal food security. Some of them are listed below:

- Caritas Internationalis' ongoing Caritas-wide initiative targeted at ending universal hunger by 2025 [48].
- IFPRI partnership compact 2025 with the participation of multiple NGOs and UN organizations establishes and broadcasts an advice (on the basis of evidence) to officials and policy makers with the aim to end the food security issue in the forthcoming 10 years by 2025 [49].
- A partnership venture jointly launched by *European Union* and *Bill & Melinda Gates Foundation* to fight against children's poor nutrition problem. This program will help to improve national nutritional policies of undernutrition countries like Kenya, Laos, Niger, Bangladesh, Burundi, and Ethiopia [50].
- FAO of the UN has developed a partnership that will perform through the framework of *African Union*'s CAADP which aimed to compete against hunger in Africa by 2025. Maintenance for better-quality food production, a consolidation of social shield, and incorporation of the Right to Food into national legislation [51].

1.11.6 World Economic Forum Contribution

Between 2007 and 2008, the global inflation in food prices from Bangladesh to Brazil and from Mexico to Mozambique enforces the World Economic Forum and its members to define a New Vision for Agriculture (NVA) in 2009 which helps to improve food security, sustainability in environment, and economic prospects every 10 years till 2050.

It mobilized the public-private partnerships which aimed to invest $ 10 billion to the nine million smallholder farmers.

This forum also launched five targeted initiatives, which have a goal to bring government, farmers, civil society, and private sector under one roof where they can share their resources and their knowledge and develop partnerships at regional and country levels.

Chapter 2
Edible Wild Plants: A Solution to Overcome Food Insecurity

2.1 What Are the Edible Wild Plants?

Wild food is considered as all the non-domesticated plant and animal resources that are collected and hunted from forests and bushlands for the purpose of human feasting. However edible wild plants can be defined as the "Plants which as whole or their any part (roots, leaves or fruits) are acceptable for eating purpose by urban and rural communities." It is very important to note that plants have many parts, i.e., stem, root, shoot, leaves, fruit, seeds, and buds, and if any part (at least one) is comestible, then that plant is considered to be an edible one. A plant considered to be an edible one could also have poisonous, medicinal, bitter, woody, and hairy parts as well. So it is very important to identify which plant is an edible one; in other case it could have disastrous consequences. The FAO defines the wild edible plants in such following words: "Plants that grow spontaneously in self-maintaining populations in natural or semi-natural ecosystems and can exist independently of direct human action" [1]. Another definition stated that WEPs as the plant species can be used as food sources and are never cultivated and never domesticated, but these can get from their wild habitat [2].

2.2 Characteristics of WEPs

The chief characteristics of WEPs are listed below:

1. They are locally accessible, and traditional ecological knowledge is considered to be the basis for their utilization [3–5].
2. They are considered as low input and cheap source for nutritional enhancement and reduction in spending restricted money resources [4, 6].

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3. They are potentially beneficial for poorer families who are extremely affected by uncertain climatic catastrophes [7].
4. They play important role in maintenance of living hoods, as they are available during the periods of famine [8–10].

2.3 Enlightenment to Wild Edible Plants

In developing nations, numerous types of edible wild plants are exploited as sources of food because these provide an adequate level of nutrition to the inhabitants. These wild food sources can also be termed as wild vegetables because they are nutritionally viable and have the ability to grow in the wild. They are important elements of natural ecosystem and agriculture because they have necessary nutritious qualities such as micro- and macronutrients, vitamins, proteins, fats, and fiber content as well. These are often considered as green factories that nature has provided us, and since ancient times they are playing role in improving human health as well as in maintenance of balance agricultural productivity.

2.4 Why Wild Edible Plants Are Important?

According to the report of the Food and Agricultural Organization (FAO), a minimum of one billion people in the world utilize wild vegetables in their daily routine diet. These wild veggies add a variety of colors, taste, and texture in our diet. The phytochemicals present in these vegetables protect human body from a great number of diseases, so that's why these wild vegetables are also called as protective food. Recently agropostoral societies have revealed that these wild plant resources not only play a vital role in nutrition but also are good sources for income generation. Wild vegetables are fascinating dietary components for poor people because these have relatively low prices as compared to the other daily routine food items and are locally available as well. Now Pakistan Agricultural Research Council (PARC) has also started research and development strategic programs with these underutilized wild vegetables.

In developing countries a significant problem to human survival is the increasing gap between the food availability and human population. So the research is based on the underutilized wild plants that can help to reduce the gap within the food deficiency and ever-growing human population. Growing and using the wild plants as food is an opportunity that is not explored properly to reduce the food insecurity and malnutrition.

The diet of the poor people is cereal based and nutrient deficient predominantly. Food insecurity results in lesser consumption of fruits and vegetables that leads to mineral and vitamin deficiency. According to a survey, due to vitamin deficiency, 0.6 million people died in 2004 and more than 190 million children lesser than 5 years old were vitamin and mineral deficient.

Wild edible plants (WEPs) are the plant species that can be used as sources of food and are never cultivated and never domesticated, but these can be obtain from their wild native habitat. Wild edible plants that are assembled in the form of one or whole parts (roots, leaves, or fruits), at the proper phase of growth, and prepared properly can be used as food. Weeds which are growing in the urban areas to indigenous plants growing in deep uninhabited region could be edible wild plants. In recent years there has been a recommence interest in wild food plants because of worldwide agitation about the quality of mass-produced crop plants, which are deprive in micronutrients.

The high extensiveness of food inhibition and contagious disease, gathered with a scarcity of approach to healthcare systems in rural areas, makes a practical alternative of conventional plant origins of food and medical treatment for endangered households. These foods have a potential to meet household food and insecurity to food.

In recent years a growing interest has emerged to evaluate the nutritional analysis of wild edible plants. Ethnobotanical information of WEPs and their nutritional analysis could be coupled to know the importance of these WEPS and to use these as food substitute. WEPs are directly approachable from natural habitats; native people have knowledge about how to gather and then produce the foods. Ethnobotanical investigation of wild edible plants has focused on the objective of the documentation of the native knowledge related to these plants. In different cultures or ethnic groups of a country or different countries, comparative studies on wild edible plants may have contribution in the identification and authentication of widely used species for further nutritional analysis.

On a daily basis, there are about one billion people in this world who use wild foods (mostly from plants). Besides it over 300 million people are there who attain a considerable part of their sustenance from wild forests or from non-timber forest products. There are about 30,000 plants from which more than 250,000 currently reported plants are edible used by human beings for household consumption. Whereas WEPs were ethnobotanically investigated, it was suggested that there are more than 7000 species which were cultivated for food purposes in the human history. In different countries such as China, India, Thailand, and Bangladesh, there are hundreds of WEPs which are consumed by the domesticated species.

Vegetables are the rich part of the human food and are the affordable energy source as these are the rich source of fats, proteins, and carbohydrates. Along with the biochemicals which were present in the vegetables, other parameters such as energy values, ash, moisture, and fiber contents of each vegetable and plant species have also been considered important for the soil quality and the human health. The important chemicals present in the wild plants have been indicated by many scientists. Vegetables and fruits (including green leafy vegetables) are rich sources of Vitamin C.

Wild edible plants are inexpensive and vital and are rich sources of antioxidants, vitamins, fiber, and minerals. Nutraceutically these plants can be used for a variety of ailments and have the power to prevent the human body from cardiovascular diseases, chronic cancer, diabetes mellitus, inflammation, and many others.

According to literature review, little attention has been given to the properties of inorganic substances that play a central role for the formation of many active and vital chemical substances, and in this way they are responsible for therapeutic and nutritional attributes.

Locally available wild herbs and plant parts are recognized for their characteristic therapeutic value, color, and flavor and are also rich sources of iron, calories, and proteins, and they are used as a part of food to manage the degenerative diseases and nutrient deficiency.

In developing countries millions of people depend on wild medicinal and edible plants, to fulfill their dietary needs and for their healthcare. Edible plants have an important part as sources of energy and micronutrients. Wild edible plants are used as food in small amounts, they handle hunger, effect on the intake of cereal staples and has a vital part in household food security for the indigent rural society. By mixing different WEPs in one food, it gives dietary diversity with reference to choice of zest and with reference to more vegetables.

Edible plants have the vital role in the traditional medicine. Trace elements present in WEPs play both curative and preventive role in combating diseases. Mostly the flora present in the developing countries virtually remains unexplored due to the medicinal utility by traditional Eastern medicinal system which strongly uses the trace elements of medicinal plants for curing several diseases. There is a small portion of mineral elements present in the plant material as compared to its total body weight and total composition, but no doubt they have important physiological role in the metabolism of human body.

Wild edible plants are available locally, so for low-income sector of the economical society, they are inexpensive. These wild edible plants contain rich amount of nutrients that have vital role in food security and nutritional point of view and are also used as the supplements to handle the illness. Modern agricultural techniques and marketing systems have become the reason of reduction in the genetic diversity of plant species, especially in vegetables, globally.

For the prosperous commercialization of wild edible plants, a good policy, robust information, and institutional environment are required that should improve the confidence of the investor in the sector. Wild edible plants provide several economic advantages to the national finance as well as to the people who are involved in the trade and cultivation of these plants.

Wild edible plants (WEPs) which are harvested locally provide food and cash income for native people and have great importance in fortifying global food security. However, with development, WEPs are endangered, and traditional knowledge which is associated with these wild plants is in danger of being lost.

The first record of edible medicinal plants in Indo-Pak was documented between 4500 and 1600 BC in Rig Veda and between 2500 and 600 BC in Ayurveda. According to estimation 46% of world's poor population lives in the South Asia. In Pakistan there is a variety of medicinal edible herbs which are scattered in the entire country because of varied climate. Eighty percent of the population of the Pakistan lives in villages and rural areas, and these plants were used in folklore medicine and hakims [10]. They depend mostly on the Unani medicine system.

Because of variable climate and soil conditions, Pakistan is very rich in flora. There are 270,000 total vascular plants found on the earth, out of which in Pakistan 6000 species of higher plants exists which include 2000 medicinal plant species.

2.5 A Brief Review of Wild Edible Plants

Wild edible plants are the raw plants which are free of cost and can be found at any place we are living. Their roots, leaves, or fruits are acceptable for eating purpose by urban and rural communities. These wild edible plants may be seasonal and can have more nutritional value than those grown in particular field in particular environmental conditions. These are fresh and more tasteful than those arranged on shelves in stores and cultivated. These wild edible plants play a significant role to improve agriculture, and some of these now become cultivated plants.

Wild vegetables increase agro-biodiversity at the household level. Although they may be consumed in small quantities, they influence the intake of cereal staples, manage hunger, and play a central role in household food security for the poorer rural groups. Several national and international researchers suggested them as alternate food resources because of their nutritional value as well as their richness in micronutrients.

Increasing rate of population all over the world has reduced the resources of food especially. To fulfill such demands, it is necessary to search for those wild edible plants which can be used in case of malnutrition, and fewer amounts are spent on them for their management. In case of natural disasters like famine, such plants can be helpful in fulfilling food demands. Hence a considerable attention is needed to explore, isolate, and characterize the phytochemical constituents to ascertain the antioxidant properties of wild edible plants. Due to frequent changes in our environment, the health and immune system of humans is badly affected. The resistance toward diseases has also decreased. In such situations we should use natural antioxidants instead of chemical antioxidants because they are less harmful and has no side effects.

2.6 Can Edible Wild Plants Be Used as an Alternative Food Source?

Day by day a significant gap is increasing between human population growth and food availability. Moreover a number of people usually fed on cereal-based diet which ultimately led to nutrient deficiencies. Therefore it has been a great challenge to provide safe and healthy nutritional sources to forthcoming generations. Hence, to meet the food and nutritional demand of human population, the researchers emphasized to search some alternative food sources. An alternate food source must be healthy and accessible which must not include the conventional foods. In this regard

wild edible plants have been emerged as striking food alternate. Previously these plants have been using for ethnomedicinal and ethnobotanical purposes by indigenous people; however it can be served as potential food source. Utilization of wild edible plants as food sources is a chance to ensure the food security and reduce malnutrition problems [11]. This fact is supported that wild edible plants are substantial part of global food basket. These plants must be associated with indigenous knowledge of particular area and have stretched history of selection and utilization [13]. The associated advantage with these plants is that they are accessible from their native habitats, and local people have preknowledge about their indigenous use [14]. These plants are capable to fight against multiple health disorders, so that health status of undernourished population can be raised. The Food and Agricultural Organization reported that at least one billion people are thought to use wild food in their diet.

2.7 Steps to Find Wild Edible Plants

2.7.1 Locate Wild Edible Plants Habitat

Firstly you must remember about the climate of your living place. If your place is humid, then you probably find the wild edible plants in those places which are sunnier. This could be clear lands or edges around the crowded plantation. However if your living region is more dry, then possibly the wild edible plants grow near watery places.

2.7.2 Preknowledge About Wild Edible Plants

Before you go into fields to search for wild edible plants, you must have preknowledge about them. You must know which wild edible plants are found around your habitat, what their identification marks are, and which could be poisonous among them. Most importantly try to learn that information as much as you could because it will be worthwhile in field.

2.7.3 Always Take Initiative from Small Scale

After getting the preknowledge rather going directly in field, you must start with small land, because without having a pilot-scale experience, you will not succeed at larger scale. You can start with grasses because all grasses are edible. Their taste ranges from sweet to mild bitter. However if you can't eat them directly, you can take in juice form.

Field showing diversified grasses

2.7.4 Start Looking to Other Areas

Once you will be able to identify the wild edible plants around your land, you can go for other areas like parks, road sides, canal banks, etc. The following are some exemplary wild edible plants which you can probably find around these areas:

- ***Taraxacum officinale*** **(dandelion)**

For this plant you must be sure that it is without whitish sap at the base of flower petiole because that sap will give you a bitter flavor. The young leaves are present in the center. You can eat the entire plant but flower is the best one. You can eat it as boiled, and you can make it as tea as well which is good for refreshment.

- ***Stellaria media*** **(chickweed)**

You can eat the entire plant as raw because it has sweet and grass-like taste. If you are not happy to eat stems, you can pluck out leaves and flowers as well.

- ***Oxalis corniculata*** **(wood sorrel)**

This whole plant is excellent to eat as raw form. It has some sour acidic flavor which brings refreshing pleasure. It is usually seen with yellow flower, but some varieties have shown pink- or white-colored flowers as well. This plant is very common in every kind of land. However in eating this you must be cautious because it

contains oxalic acid. Although oxalic acid is very good for human health, high intake of oxalic acid could cause stomach problems.

2.7.5 Look for Berries

Many ornamental shrubs have berries and they are quite good for eating. For instance silver berry is very good in this regard. Its leaves show silvery appearance and its berries are juicy to eat.

2.7.6 Search for Berries on Trees

You can also find the berries on trees. Most wild cherries can be found in winters as well.

2.7.7 Search for Nuts Underneath the Trees

Fresh nuts are usually wet and more digestible with better flavor. Have you seen the oaks? There are so many acorns under the oak trees. The acorns will require less or no processing time if they are obtained from the oak tree with lobed leaves. Some

white oak acorns usually don't have the tannin. However once you start eating them, you will get used to it.

2.7.8 Look for Fruiting Trees

Look around the road sides, forest edges, and canal banks for fruiting trees. More commonly you will find the fruity trees at places which are sunnier because fruit needs sun to be ripened so they are hardly found in the middle of woody forest. You can find some wild apples, mulberries, hackberries, autumn olive, and so on.

Wild apples

Wild mulberries

2.7.9 Search Plant Near Water Bodies

Look around the water bodies and search for some plants like cattail, watercress, and bulrush. Cattail is usually found in stagnant water, but it can also be seen along streamsides. It can also outrage itself to the lakes and bays. Its shoot and pollen are both edible. The pollen is best considered for making flour, and it is one of the healthiest wild edible plants.

2.7.10 Be Aware of Poisonous Flowers

Flowers are usually sweet and rich in antioxidants, but sometimes, they could be poisonous as well. So before eating, make sure that it's not poisonous. Usually poisonous flower has strong base which could have bitter taste. For instance the flower of Azaleas is deadly poisonous.

2.7.11 Search for Vines

Wild grapes are more commonly found around the forest areas. The good thing about it is that not only its fruit but its leaves and tendrils are also edible.

2.7.12 Look for Deciduous Leaves

The deciduous leaves of sassafras, box elder, and sourwood are excellent raw food. Along with these, beech leaves are also preferably edible plant in young state. These leaves can be used as salads. Leaves of linden can be used as tortillas.

Sassafras

boxelder

Beech leaves

2.7.13 Conifer Leaves

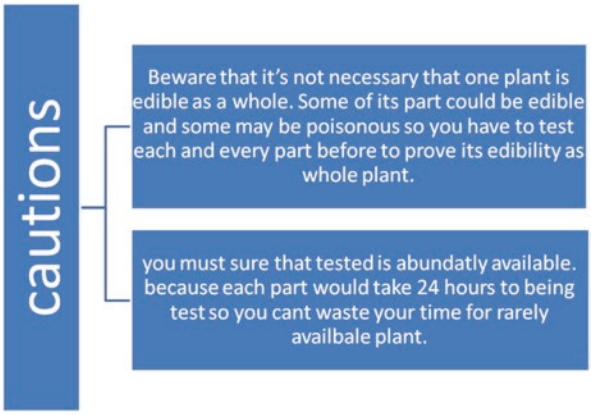
The young conifer leaves with acidic flavor are delicious to eat and good for health. The small tender male cones are also edible, and its pollen is full of nutrition. Many pines also have the nuts, which fall in late summers.

2.7.14 Test for Poison for Unknown Wild Edible Plants

If you are not hundred percent sure that you have found the right plant, still, DON'T rush to eat it. Some plants are too lethal; even in minor amounts, they can indeed harm you. There are general prescribed test for wild edible plants which are unknown to you.

- Test only single part at a time for any wild edible plant.
- Always separate out the plant's basic reproductive and vegetative part like root, stem, leaves, bud, and flowers.

- Smell for plant odor; either it has fruity, acidic, or irritating odor. However the plant odor can never directly indicate its edibility.
- Test for its poisonous action by putting it under the elbow or writs for 15 min at least. If the plant is poisonous, it will start allergic reactions to your skin.
- During the test period, you should not eat or drink anything else except water and that under test plant part.
- Select the part which you like to eat and think about its preparatory method, whether you want to eat it raw, boiled, or mixed with any other food.
- Before taking in that plant part, put a pinch of it at the edge of your lips and test it for itching reactions.
- If for 3 min you feel no burning sensations on your lips, then roll in with your tongue and hold for 15 min there.
- If still you feel ok with it, start to chew it but do not dare to swallow. Just chew it for 15 min.
- If now for 15 min, you felt no burning or numbing reactions, you are allowed to swallow that.
- Now you have to check for a minimum of 8 h. During this 8 h, if you feel any kind of illness, you have to induce vomiting or take boiled water.
- If you will feel ok till 8 h now, take another doze of that plant part and monitor yourself for another 8 h. If you are still ok, then that plant part is proved to be edible.



Here are some keys to avoid the poisonous plants. Avoid that part or plant if having one of the following features:

- Milky or tarnished sap
- Beans, bulbs, or seeds in the pods
- Bitter or foamy flavor
- Spines, adequate hairs, or thorns
- Dill-, carrot-, parsnip-, or parsley-like foliage
- "Almond" aroma in woody parts and leaves
- Grain heads with spurs of pink, purplish, or black color
- Three-leaved growth pattern

These criteria are good and usually avoids your time to be wasted, but sometimes the plant is not that much poisonous even with that indicators. So by following these criteria, it is advantageous in narrowing your scope of search but at the same time has drawback to reduce the diversity of studied wild edible plants.

2.7.15 Collect Those Plants Which Are Abundant

Always try to collect and eat those plants which are abundantly available in wild. In other case developing an eating habit to less abundant plant will cause no benefit. However by doing this you can negatively affect its diversity status.

2.7.16 Avoid to Look Around Trashes

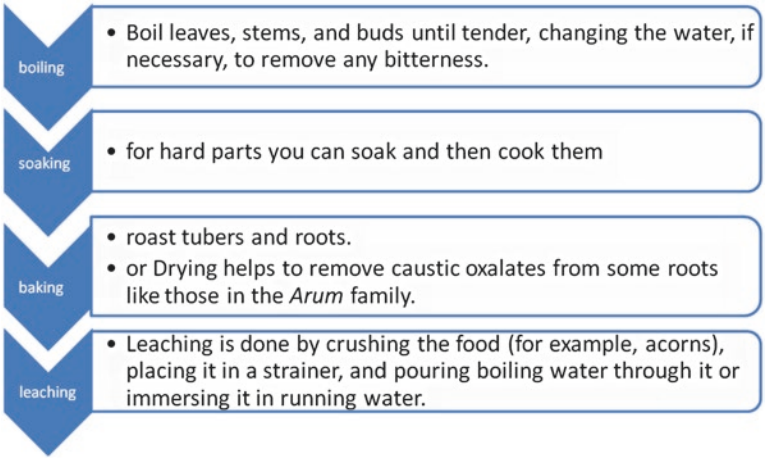
Never pick wild plants from the trash or polluted areas because they might be the store house of unknown dangerous chemicals. So beware in collecting them.

2.7.17 Washing Rule

Whenever you collect any wild edible plant, you must wash it thoroughly to avoid all the soil and airborne containments. It is very important for your health and safety.

2.8 General Preparatory Methods for Wild Edible Plants

- **Raw**
  Most of the wild edible plants can be eaten as raw. You can eat them as fruits or as salad.
- **Cooking**
  You can also cook the plant or part of plant which is edible or palatable. Both these terms are interrelated because all palatable plants are edible, but all palatable plants do not necessary to be palatable. Because edibility only means that that particular plant or its part is fulfilling your energy demands, however palatability means that whether it is satisfying your taste buds or not. Wild edible plants more commonly satisfy the edibility criterion rather than palatability.
  However through a number of methods, you can improve its tastes such as the following:



- To remove the bitterness of acorns, you can boil, bake, and leach them in water. Some nuts, like chestnuts, are good if raw, but their tastes improve if roasted.
- You can eat a number of grains and seeds in raw form until they mature. When they become hard or dry, you can boil or grind them into meal or flour.
- The sap from many trees contains sugar like maples, birches, walnuts, and sycamores. This sap could be boiled to make sweetening syrup.

Chapter 3
Diversity of Edible Wild Plants: Global Perspectives

Food security is the main issue of this time, and we know that dependence just only to cultivated species cannot assure the food security. We have to look for edible wild plant resource as well. More than 50% of our daily protein and caloric requirements covered by only 3 crops, i.e., wheat, rice, and maize, and only 12 species are making the 80% of our total dietary intake [11]. However, this diet can be diversified by integrating the wild edible plants into our diet plan. Ethnobotanical studies had revealed that more than 7000 species have been used by humans as food in prehistoric times [8, 9].

Over 200 indigenous communities in India give food value to 600 plant species [10, 11]. Some 1069 species of wild fungi consumed worldwide are important sources of protein and income [12]. Furthermore, wild plants in particular have diverse uses like in Nepal, 80% of 62 wild food plants have been reported with multiple uses [23]. Tanzanian Batemi agropastoralists use species as food (31 species), as thirst quenchers (6 species), for chewing (7 species), as flavorants (2 species), and for honey beer (1 species). In the Mekong Delta and Central Vietnamese Highlands, several wild food species are used as medicine and livestock feed; one fifth are used as all three [21]. Wild edible plants (WEP) provide staple and supplement foods, as well as cash income to local communities, thus favoring food security. However, WEP are largely ignored in land use planning and implementation, economic development, and biodiversity conservation.

3.1 Classification of Wild Edible Plants

Wild edible plants have been classified in different ways. Some of the noteworthy classifications are listed below:

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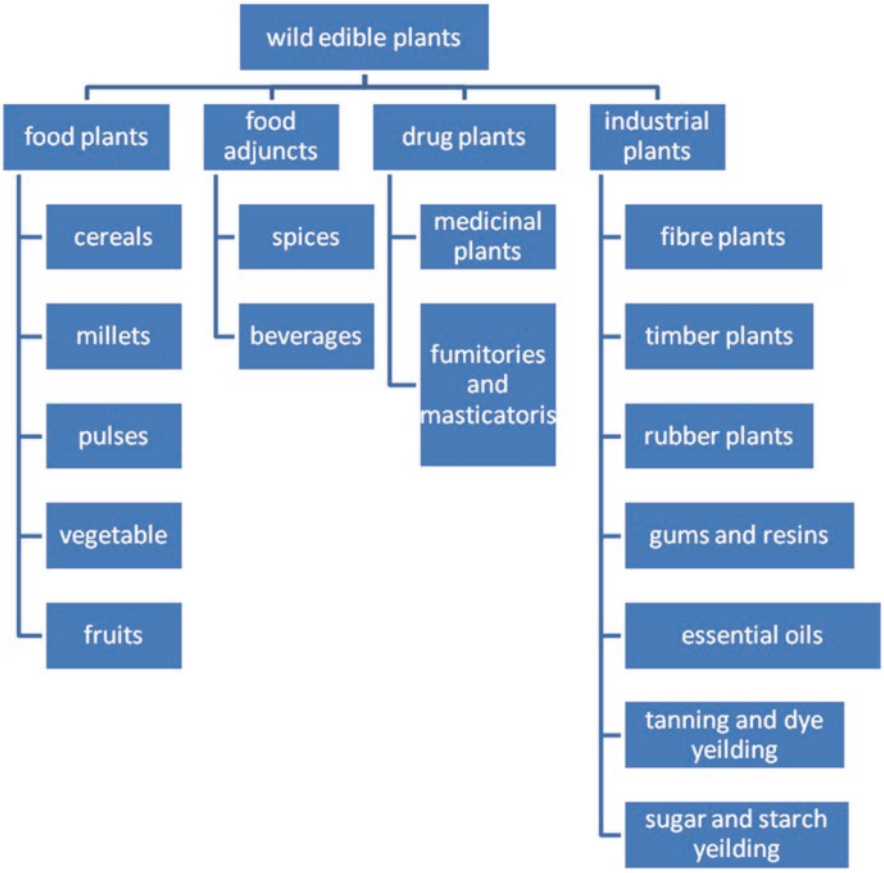
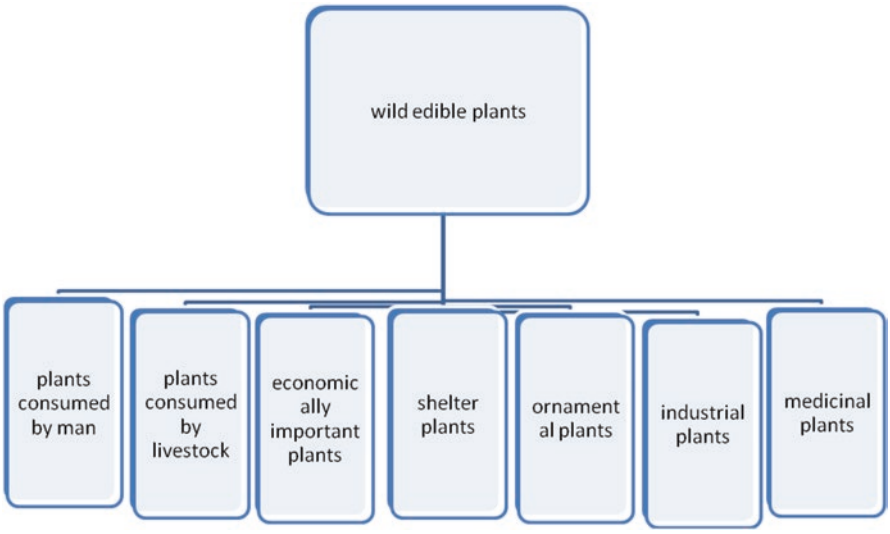
(a) **Hill's classification**
This classification was set up in 1952 by Hill, and according to him, wild edible plants can be categorized as follows.



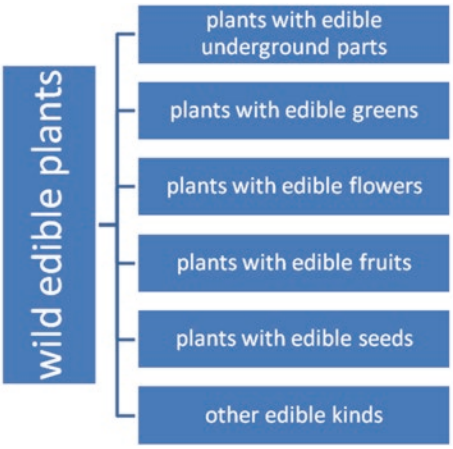
(b) **Brouk's classification**

In 1975 Brouk divided wild edible plants into seven classes.



(c) **Singh and Arora's classification**

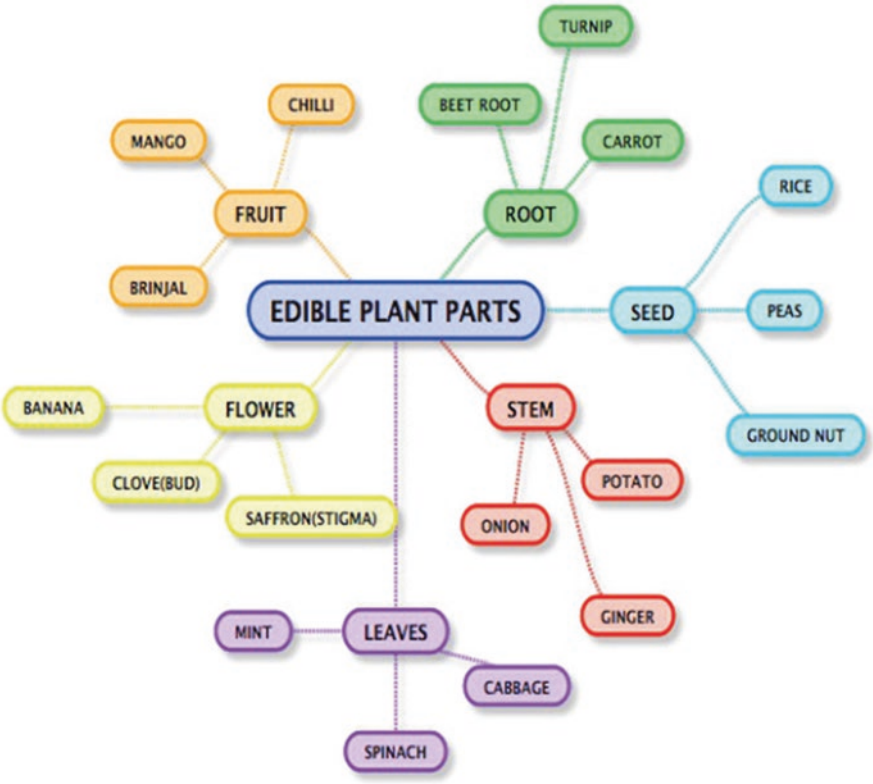
In 1978 two researchers Singh and Arora first time classified the wild edible plants in their true sense. They didn't include the economic perspective of plants; rather their focus was to classify them based on their edible properties.



3.2 Wild Edible Plant Systems

Wild edible plant systems are basically plant parts which are eaten by humans. Plants are made up of stems, roots, flowers, leaves, buds, and seeds. Wild edible plants can be classified into different categories based upon their plant part used. The category *edible plants* include plants with parts that are safely edible by humans. The categories can be termed as:

- Edible plant stem
- Edible flowers
- Edible fruits
- Edible roots
- Edible leaves
- Edible seeds



Edible plant parts system.

Source: http://en.wikipedia.org/wiki/edible_plant_stem

3.3 Some Important Families of Wild Edible Plants

There are so many different kinds of plants out there in the world. It can really help to initially lump them into more manageable groups. Here are some of the major groups of wild edibles, organized by plant families:

The Lily Family (Liliaceae). This includes species such as:

- Wild onions
- Wild garlic
- Wild leeks
- Camas
- Glacier lilies

The Purslane Family (Portulacaceae). This includes:

- Miner's lettuce
- Spring beauty

The Rose Family (Rosaceae). This includes edible plants such as:

- Blackberry
- Raspberry
- Salmonberry
- Thimbleberry
- Wild roses
- Hawthorn
- Serviceberry
- Chokecherry
- Wild strawberry
- Silverweed

The Heath Family (Ericaceae). This includes species such as:

- Cranberry
- Blueberry
- Huckleberry

The Mustard Family (Brassicaceae). This includes plants such as:

- Pennycress
- Shepard's purse
- Watercress

The Mint Family (Lamiaceae). This includes wild edibles such as:

- Wild mint
- Self-heal

The Sunflower Family (Asteraceae). This includes species such as:

- Dandelion
- Wild sunflower
- Salsify
- Chicory
- Pineapple weed
- Oxeye daisy
- Common burdock
- Thistle species

The Nettle Family (Urticaceae). This includes:

- Stinging nettle

The Cattail Family (Typhaceae). This includes:

- Narrowleaf and broadleaf cattail

The Beech Family (Fagaceae). This includes:

- Oaks
- Chestnuts
- Beeches

The Pine Family (Pinaceae). This includes trees such as:

- Pine
- Hemlock
- Douglas fir
- Spruce

Chapter 4
Status of Edible Wild Plants in Pakistan: Case Studies

4.1 *Berberis lycium* Royle

Fig. 4.1 *Berberis lycium* Royle. (**a**) Flowering branches. (**b**) Fruiting in natural habitat

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DOI 10.1007/978-3-319-63037-3_4

4.1.1 Systematic Studies

Botanical name	:	*Berberis lycium* Royle
Family	:	Berberidaceae
Common name	:	Indian barberry, boxthorn barberry
Local name	:	Barberry (English), kushmul (Pashto), simblu (Punjabi), zarch (Urdu)
Conservation status	:	Common in the wild
Habit/habitat	:	Shrubberies and open hillsides usually on hot dry slopes to 3000 m in Kashmir
Blooming time	:	April to May
Fruiting period	:	May to July
Distribution		
World	:	Found throughout the temperate and subtropical regions of the world (apart from Australia). It is common in Europe, North Africa, the Middle East, and Central Asia
Pakistan	:	Kurram, Dir, Chitral, Hazara, Kashmir, Gilgit, Swat, Siran Valley, Murree

4.1.2 Ecology

It is used as food plants by the larvae of some Lepidoptera species, including a moth. This shrub serves as alternate host species of the wheat rust fungus (*Puccinia graminis*), a grass-infecting rust fungus that is a serious fungal disease of wheat and related grains. For this reason, cultivation of *Berberis lycium* is prohibited in many areas. This sometimes become invasive when planted outside of their native ranges, with the most remaining occurrences in the mountains.

4.1.3 Morphological Description

Shrub, 2–3 m tall, erect or suberect, semideciduous; stem and branches pale, whitish to grayish, terete to subsulcate, glabrescent, younger ones obscurely to distinctly puberulous; internodes 1.5–3.5 cm long; spines (6–20) mm long, yellowish to straw-colored. Leaves oblanceolate to oblong -obovate, 2–6 cm long, 6–12 mm broad, subsessile, usually conspicuously papillose, gray or white below, entire to 2–4 spinulose at the margins, acute to subacuminate, openly veined. Racemes 6–25 flowered, 3–7 cm long, rarely shorter, and subfascicled (2–2.5 cm). Flowers 6–8 mm across, usually pale yellow; pedicels 6–12(−15) mm long, rarely longer, slender, thin, glabrous; bracts 2–2.5 mm long. Outer sepals much smaller than the middle

and inner sepals; inner sepals 4.5–5 mm long, 3 mm broad, obovate. Petals slightly shorter than the inner sepals, obovate, emarginate, with lanceolate basal glands. Stamens slightly shorter than petals, connectives produced or anthers apiculate. Ovules usually 4, shortly stipitate. Berries 7–8 mm long, ovoid or obovoid-subglobose, excluding 1 mm long style, blackish with heavy gray-white bloom; seeds 3–4 mm long.

4.1.4 Organoleptography

Unripe fruit is light green. It is dark violet blue in color when riped with bluish-black pericarp and light brown notch. Fruit is oval to round in shape. Fresh berries are succulent, axillary, fleshy, and juicy. Dried fruits have irregular shape. Unripe dried fruit is smooth and hard in texture, irregularly soft with slight ridges and furrows having hard and woody notch. Length of fresh fruit ranges from 0.5 to 0.9 cm having 0.6–1.9 cm diameter. Dried fruit length is less than the fresh one, i.e., 0.3–0.7 cm and diameter 0.5–1.6 cm. Unripe fruit is sour to bitter but pleasantly acidic when fully riped. Fruit is deep reddish brown when fully riped. Fresh fruit is pleasant, while dried fruit is mild. Surface of fresh fruit is smooth, while ripened dry fruit is soft and flexible. Single obovate seed is present inside the fruit, dark brown, smooth, and brittle externally but yellowish brown and bitter inside. Seed is 0.1–0.3 cm long and 0.2–0.5 cm diameter.

4.1.5 Edible Potential

Parts used: fruit, leaves, root bark

4.1.6 Edible and Medicinal Uses

Ripened berries are eaten raw or cooked and made into preserves. They are fairly juicy with a nice slightly acidic flavor. Leaves and young shoots are cooked. Leaves are also used as a tea substitute. A yellow dye is obtained from the root. Wood is used as fuel. Bushy plant is used as hedge by the locals.

Indian barberry's roots known as "Darhald" are used as remedy for swollen and sore eyes, ear diseases, malarial fever, diabetics, jaundice, skin disease, broken bones, wounds, gonorrhea, throat pain, curative piles, unhealthy ulcers, acute conjunctive, and in chronic ophthalmia and also used as bitter tonic for piles. In Pakistani folk

medicine, the root powder of the plant is recommended for the treatment of rheumatism and muscular pain, and it is to be taken with milk probably to protect the gastric mucosa from damage. Root extracts have been used as eye lotion. Leaves are given in jaundice, piles, and diarrhea. Fruit is useful in typhoid, common fever, and teeth troubles.

4.1.7 Folk Preparations

(a) Root bark (2–3 small pieces) is chewed three times daily for fast healing of bone fracture.
(b) Dried berries (10–15) are boiled in water (500 mL) until one half of the mixture is left. This decoction is cooled, filtered, and given to the patient (2 tablespoons) three times a day in typhoid and common fever.
(c) Root bark (10 g) is mixed with melted ghee (3 g). This mixture is applied as bandage (once daily) on the broken bones.
(d) Fresh leaves (50 g) are crushed to obtain extract. This leaf extract (2 mL) is taken twice a day in jaundice.
(e) Root bark pieces (15 g) are boiled in water (750 mL). This infusion is used as gargles (in morning and night times) to cure sore throat.
(f) Dried fruit powder (5–7 g) is taken once daily in dysentery.
(g) Dried powder of root bark (10 g) is mixed in water (75 mL) along with sugar powder (15 g). This mixture (3–5 g) is taken daily before sleeping, which is effective for jaundice and stomach ulcer.
(h) Concentrated juice of berries (5 mL/40 g) is used for gums and teeth trouble.

4.2 *Cydonia oblonga* Mill

Fig. 4.2 *Cydonia oblonga* Mill. (**a**) Flower (**b**) Ripened fruit in natural habitat

4.2.1 Systematic Studies

Botanical name	:	*Berberis oblonga* Mill
Family	:	Rosaceae
Common name	:	Quince tree, quince bush
Local name	:	Behi (Hindko)
Conservation status	:	Commonly cultivated in Baluchistan, Chitral, and Kashmir. Occasionally in the plains
Habit/habitat	:	Woodland Garden Secondary, Sunny Edges, Dappled shade, Shady edge
Blooming time	:	May to June
Fruiting period	:	September to October
Distribution		

Botanical name	:	*Berberis oblonga* Mill
World	:	Distributed in the Caucasus (Western and Eastern Ante-Caucasus, Daghestan, Eastern and Southern Transcaucasia, Talysh) and Central Asia. The distribution of wild-growing quince in other areas of Central Asia has not been proven. It also grows in Iran, Turkey, Afghanistan, and Pakistan. The species became widespread, due to cultivated forms, and naturalized over almost the entire Mediterranean region. Native to Central Asia, cultivated in Europe, Temperate areas of Pakistan
Pakistan	:	Gilgit, Kashmir, Waziristan, Kurram agency, Swat, Chitral, Hazara, Mansehra

4.2.2 Ecology

Mesoxerophyte grows in the underbrush of downstream liana forests; in oak groves with hornbeam; on forest edges and glades; in the thickets of xerophilous shrubs on dry, frequently carbonate soils; and in alluvial soils of river valleys, where it survives temporary floods. In the mountains, it grows as high as the middle mountain zone.

4.2.3 Morphological Description

Species is a deciduous tree or shrub that grows up to 1.5–5 m tall. The stem is covered with thin, scaly bark. Young shoots are wooly tomentose but later become bare. Leaves are 10–12 cm long and 5.7–7.5 cm wide, ovate or oval, smooth-jagged edged, acute or obtuse at the top, with a short cusp on the tip, dark green, bare from above and grayish tomentose from below; young ones are cobwebby tomentose from above. Stipules are adenodentate. Flowers are solitary, pale pink, up to 5 cm in diameter, set on short pedicels. Pedicels, receptacle, and outer side of sepals are covered with tomentose pubescence. Sepals are oval, adenoserrate along the edge. Fruits are 2.5–3.5 cm in diameter, tomentose in the beginning and bare when mature, lemon yellow or dark yellow, for the most part slightly costate, round, or pear shaped; their pulp is not juicy, with numerous sclereids, astringently sweet in taste, very fragrant.

4.2.4 Organoleptography

Fruit is greenish yellow when unripe with dense hairs, surface rough externally, subglobose in shape astringent and with pale dots. When ripe, the fruit becomes bright yellow in color, hard, and rough in texture. Taste is somewhat sweet then acrid. Fruit is globose to pear shaped and 10–20 cm in diameter. Pedicel 2–3 cm long, seeds are dark brown in color and disc shaped. The fruit (epicarp, mesocarp, and endocarp) is indistinct.

4.2.5 Edible Potential

Parts used: fruit, leaves

4.2.6 Edible and Medicinal Uses

It is used for food and as an ornamental plant. Quince is considered one of the best frost-resistant stocks for the pear tree. Species shows promise for hybridization, endures clipping quite well, and is suitable for green hedges. Cydonia oblonga is used to prepare a variety of recipes. It is used to make jam, jelly, and quince pudding. The fruit can be eaten in the raw as well as in cooked form. If the fruit smells very strong, it can be added in small quantities to apple pies and jams to enhance their flavor. The popular jam called marmalade is made using quince, and its name has been derived from "marmelo," the Portuguese word for the fruit. Cydonia oblonga is also used in making a type of wine. The seeds of Cydonia oblonga are used in the cosmetic industry and for medicinal cosmetics. Quince is eaten in sandwiches, with cheese (traditionally manchego cheese) or fresh curd.

It has been reported that the leaves and fruits of quince have some positive effects in the medical treatment of various conditions, including cardiovascular diseases, hemorrhoids, bronchial asthma, and cough. Pomes of quince, known in Italy as "cotogna" apple, have hard flesh of high flavor but very acidic, and these are largely used for marmalade, liqueur, jelly, and preserves. Quince fruit is recognized as a good, cheap, and important dietary source of health-promoting compounds, due to its biologically active constituents which are characterized by their antioxidant, antimicrobial, and anti-ulcerative properties. It has protective effect against oxidative hemolysis of human erythrocytes. Quince seed mucilage has a wound healing activity. Leaves have been used, after decoction or infusion, in folk medicine for their sedative, antipyretic, anti-diarrheic, and antitussive properties and for the treatment of various skin diseases. Seed is used for dysentery, diarrhea, and sore throat; fruit is useful for cardiac diseases, unripe fruit as remedy for diarrhea; and mucilage is externally used to cure ulcers. Leaves, buds, and barks are considered as astringent. Seed is demulcent, used in dysentery, diarrhea, sore throat, and fever. Fruit is cardiac tonic, expectorant, and astringent.

4.2.7 Folk Preparations

(a) The fruit juice (40–50 mL/5–6 fruits) can be taken (two tablespoons three times per day) as to treat mouth ulcers, gum problems, and sore throat.
(b) Crushed seeds (15–20 g) have a considerable amount of mucilage (4–6 g) which is given (1 teaspoon twice a day) to cure bronchitis and constipation.

(c) It is also used as compresses or poultices (paste of the leaves 20 g powder mixed in 10 mL of water two to three times/day) for injuries, inflammation of the joints, injuries of the nipples, and gashed or deeply cut fingers.
(d) *Cydonia oblonga* is used as an infusion to treat diarrhea and hemorrhage of the bowel**.** Dried flowers (250 g) are boiled in water (500 mL). This mixture is filtered, and two to three teaspoons (20 mL) is given (two to three times/day) to patient to treat diarrhea and hemorrhage of the bowel.
(e) A teaspoon of quince jam, when dissolved in a cup (100 mL) of boiling water, is given to the patient; they help in relieving intestinal discomfort.

4.3 *Daphne mucronata* Royle

Fig. 4.3 *Daphne mucronata* Royle. (**a**) Flowering branch (**b**) Unripened fruit

4.3.1 Systematic Studies

Botanical name	:	*Daphne mucronata* Royle
Family	:	Thymelaeaceae
Common name	:	Common shrub
Local name	:	Kuttilal (Hindko); pipal (Baluchi)
Conservation status	:	Common in the wild
Habit/habitat	:	Xerophytic shrub common along riverbanks from 800 to 3000 m
Blooming time	:	April to August
Fruiting period	:	September to October
Distribution		
World	:	Main distribution area is the Asian region including Afghanistan, West Pakistan, Iran, North Africa, and Southern Europe. In Europe, the main distribution area is in the southern mountains. The distribution of the *Daphne oleoides* is limited to the northern hemisphere.
Pakistan	:	Nathiagali, Murree, Hazara, Kaghan, Poonch, Malakand, Swat, Gilgit, Baltistan, Siran valley

4.3.2 Ecology

A xerophytic shrub common along riverbanks from 800 to 3000 m. *Daphne mucronata* lies between the oak forests and the higher thorn-cushion (subalpine) vegetation habitat. It is an early-flowering, evergreen shrub growing in the undergrowth of shady mountain forests. It prefers a cool lime-free well-drained friable soil. Plants usually require an acidic soil and survive in any well-fed and well-drained soil in sun or part shade. This species tolerate temperatures down to about −5 °C. Plants are resentful of root disturbance and should be planted into their permanent positions as soon as possible.

4.3.3 Morphological Description

Bushy habit, shrubs usually up to 2.5 m tall but occasionally more. Younger branches often tomentose. Leaves alternate or scattered, 3–5.8 cm long, 0.4–1 cm broad, elliptic-oblong to lanceolate, mucronate, less often obtuse, coriaceous, sessile, grayish green, hairy, at least when young, leathery. Flowers cream to white, sometimes pink tinted, in axillary or terminal clusters of two to eight, subsessile, fragrant. Corolla tube 6–8 mm long, tomentose, dilated at the base, four-lobed; lobes ovate to obovate, 4 mm long, spreading. Stamens 8, 2-seriate, upper 4 antisepalous, subsessile. Ovary ovoid, 2.5 mm long, pubescent. Style absent; stigma capitate. Berry subglobose, 10 mm long, pubescent, orange.

4.3.4 Organoleptography

Berries are dull green in unripe form and deep orange when ripe. Fruit is axillary, edible, sour, fleshy and berry, oval in shape, 0.7–1.3 cm long, 0.2–0.8 cm wide, and 1.6–2.3 cm circumference. Exocarp, mesocarp, and endocarp are distinct. Exocarp (peel) is deep orange, glabrous, smooth with spotted surface, and sour in taste. Mesocarp (pulp) is orange to fresh yellow, soft, sweet, and fleshy. Endocarp (seed) is externally blackish brown, internally light brown, bitter, and solid. Seed is oval in shape, 0.1–0.3 cm long and 0.3–0.5 cm in diameter.

4.3.5 Edible Potential

Parts used: whole plant

4.3.6 Edible and Medicinal Uses

Dried branches are used as fuel. Bark is used as rope to tie the grass bundles and also tied in the neck of dogs to repel flies. The leaves are poisonous but are tolerated by goats. Gunpowder charcoal is said to be made from the wood. The fruit can be eaten and is used as a dye for leather. The fruits of the plants are harmless for birds and provide a welcome food source. The birds excrete the undigested seeds and thereby spread the seeds. One commercial use is barely the manufacture of paper. In the Asian region, the bark is used for handmade paper. This noble paper is used for important documents and religious texts or is exported. It has beautiful flowers and can be used as ornamental plant.

The bark is used in diseases of the bone. Leaves are useful for gonorrhea, muscular pains, and nerve problems. The leaves are also applied to abscesses. Seeds can be used for skin diseases. The roots are purgative. Fruit is useful for rheumatism and face freckles and is internally used for eye problems.

4.3.7 Folk Preparations

(a) Dried berries (18–20) are boiled in two cups (500 mL) water, and this decoction (10–15 mL) is taken at night for releasing throat pain.
(b) A poultice made from dried leaves and bark (30 g each) is useful for tumors and swellings.
(c) Dried fruit powder (20 g) is mixed with water (100 mL), and the paste produced is used for rheumatism, pimples, and freckles on face.

(d) An infusion of the bark and leaves is made by boiling dried powder (25 g each) in two cups of water (500 mL). This infusion is applied externally (three times per day) in the treatment of cutaneous affections.

4.4 *Debregeasia salicifolia* (D.Don) Rendle

Fig. 4.4 *Debregeasia salicifolia* (D.Don) Rendle. (**a**) Inflorescence (**b**) Fruiting branch

4.4.1 Systematic Studies

Botanical name	:	*Debregeasia salicifolia* (D.DON)
Family	:	Urticaceae
Common name	:	Wild rhea
Local name	:	Sandoori (Urdu), chinjli (Hindko), siharu (Panjabi), kharawa (Pashto)
Conservation status	:	Common in the wild

Botanical name	:	*Debregeasia salicifolia* (D.DON)
Habit/habitat	:	Shady, moist places by streams, forests in mountain valleys; 1700–2300 m
Blooming time	:	March to May
Fruiting period	:	June to August
Distribution		
World	:	Common in moist places in the Northern Himalayas up to 2000 m. India, China, Pakistan, Afghanistan, Nepal, Iran, and Tropical Africa (Ethiopia)
Pakistan	:	Dir, Chitral, Swat, Gilgit, Balakot, Murree, Hazara, Kashmir, and Salt range (Punjab)

4.4.2 Ecology

Commonly found on rocky slopes in dry forest, humid parts of ravines, along margin of evergreen and secondary forests up to 1800 m. Suitable for light (sandy), medium (loamy), and heavy (clay) soils with acid, neutral, and basic (alkaline) pH. It can grow in semi-shade (light woodland). It prefers moist soil, fertile well-drained loam with some shelter at the hottest part of the day. Plants are not very hardy; they require greenhouse protection. The fruit is difficult to harvest because it is tender and falls apart easily; therefore, it is not suitable for commercial cultivation. The fruit remains on the plant for several weeks and looks particularly ornamental.

4.4.3 Morphological Description

A large shrub 2–5 m tall, erect, branched. Branches dark purplish, young branchlets and petioles sparsely spreading hirtellous, slender, erect or ascending and mixed snow-white tomentose above, glabrescent with warm red-brown cortex below. Stipules oblong lanceolate, 6–10 mm, glumaceous, brown, linear-lanceolate, hairy on the two prominent nerves, soon falling two cleft at apex, tomentose along veins abaxially. Leaves shortly stalked, stiffly membranous or subcoriaceous when dry, narrowly lanceolate, apex tapering acuminate, base obtuse, margin serrulate, 5–15 long × 1.5–4 cm wide, 3-nerved, the lateral basal nerves slender failing about the middle of the leaf and anastomosing with the delicate upper nerves, cross-unions regular, parallel, upper face sparsely hairy when young, soon becoming glabrous, scabrid, and often rugulose, lower face white tomentose; petiole 0.5–3 cm long, slender, tomentose, secondary veins 4–6 on each side from middle of leaf, anastomosing at margin, abaxial surface thickly snow-white tomentose, fine veins invisible, sometimes sparsely appressed pubescent on main and secondary veins, adaxial

surface sparsely appressed strigose, sometimes rugose, base rounded, margin finely serrulate, apex acuminate. Heads of flowers about the size of a pea, male, female, or sometimes androgynous, solitary or two to four in the leaf axils, sessile, or shortly stalked. Inflorescences borne always on previous years' branches, often flowering before leaf flush, one to two dichotomously branched or solitary, 0.5–1 cm; peduncle 0–0.5 cm, appressed pubescent; glomerules globose, 4–6 mm in diam.; bracts obovate, 2.5 mm in size, membranous. Male heads few flowered, larger than the female; shortly pedicellate, flattened in bud, 1–1.5 mm in diameter; perianth lobes (three or four), triangular-ovate, densely white tomentose abaxially, connate at base, apex acute; ovary rudiment blunt, glabrous. Female heads many flowered; flowers much smaller than the male, subtended by small brown scarious bracteoles, narrowly obovoid. Fruiting heads yellowish orange, globular, 2–3 mm in diameter, sometimes uniting in pairs; berries about 0.5–1 cm long, stipitate at base, enclosed by fleshy perianth and adnate to it, tipped with the dried remains of the stigma.

4.4.4 Organoleptography Studies

Dried fruit looks like ball composed of many fine compact grains or granules. Fruit is achene, mucilaginous, globular, soft to touch, sweet in taste, and brownish orange. Fruits are 0.2–0.7 cm long, 0.1–0.3 cm wide, and 0.6–1.5 cm in diameter. Fruits are directly attached to the branches. Seed are solitary. The fruit (epicarp, mesocarp and endocarp) is indistinct.

4.4.5 Ethnobotanical Data

Parts used: whole plant

4.4.6 Local Uses

A strong fiber is used to make ropes and is obtained from the bark. Bark is also used to wash hairs by ladies. Leaves are used as fodder for sheep, goats, and cattle. The stem fibers are used to make ropes and fishing nets. The fruits are edible—raw or cooked. Fruits are sweet but insipid and mucilaginous, about the size of a pea. They are used as a flavoring agent and to make wine. Wood is used for making handles of tools and also as firewood. The branches are in roof thatching along with mud.

4.4.7 Medicinal Properties

Whole plant is medicinal having stomachic and astringent properties. Leaves are useful for earache, skin diseases, and scabies. Fruit is used for stomach disorders, constipation, diarrhea, and dysentery.

4.4.8 Folk Preparations

(a) Fresh leaves (40–50 g) are blended in water (15–20 mL) and filtered. This extract is applied (three times a day) to areas of the skin affected by scabies.
(b) Dried fruits (25–30 g) are ground to fine powder and soaked in water (one and a half cup, i.e., 375 mL) overnight. The extract is filtered in the morning and mixed with yogurt (50 g). Two teaspoons of this drug are given (two to three times per day) to the patient suffering from diarrhea and dysentery.
(c) The dried leaves (30 g) are decocted in two cups of water (500 mL). This decoction is strained, cooled, and applied externally to reduce skin itching.
(d) The seeds (10–15 g) are ground. Two teaspoons of powdered drug (6–8 g) is taken orally (at night) with a cup of boiled water (250 mL) for treatment of constipation.
(e) Leaves (22–25 g) are boiled in a cup of water (125 mL) and covered with a lid. This infusion is cooled and strained. Two to three drops of this solution is poured once a day (preferably at night time) into the ear to treat earache.

4.5 *Ficus racemosa* L.

Fig. 4.5 *Ficus racemosa* L. (**a**) Fruiting in natural habitat. (**b**) Fruit

4.5.1 Systematic Studies

Synonym	:	*Ficus racemosa* L.
Family	:	Moraceae
Common name	:	Cluster fig tree, Indian fig
Local name	:	Gular (Urdu)
Conservation status	:	Common in the wild
Habit/habitat	:	Evergreen deciduous tree found mostly on the banks of rivers and water courses, where the soil is rich and moist
Blooming time	:	March to May
Fruiting period	:	September to November
Distribution		
World	:	Native to Australia, Malaysia, Southeast Asia, and the Indian Subcontinent like Pakistan, India, Sri Lanka, Bangladesh, Southern China, Burma, Thailand, Malaysia
Pakistan	:	Swat, Dir, Hazara, Murree, Margalla Hills, Rawalpindi, Mirpur, Salt range, Changa Manga

4.5.2 Ecology

It prefers continental climate with hot summer. Moist areas, beside rivers and streams, occasionally in streams; 100–1700 m; found along the riverbanks and inland forests from plains to 1500 m. Grows in dry rain forest, beach forest and gallery forest sometimes in areas which are otherwise quite dry and not conducive to rain forest development.

4.5.3 Morphological Description

Deciduous trees, to 30 m high; bole buttressed; bark 8–10 mm thick, surface reddish brown or yellowish brown smooth, coarsely flaky, fibrous; blaze creamy pink; latex milky; young shoots and twigs finely white hairy, soon glabrous; branchlets 1.5–3 mm thick, puberulous. Leaves simple, alternate, stipules 12–18 mm long, lanceolate, linear-lanceolate, pubescent, often persistent on young shoots; petiole 10–50 mm long, slender, grooved above, becoming brown scurfy; lamina 6–15 × 3.5–6 cm, ovate, obovate, elliptic-oblong, elliptic-lanceolate, elliptic-ovate or oblong-ovate, base acute, obtuse or cuneate, apex narrowed, blunt or acute, margin entire, membranous, glabrous, blistered appearance on drying; 3-ribbed from base, 4–-8 pairs, slender, pinnate, prominent beneath, intercostae reticulate, obscure. Flowers unisexual; inflorescence a syconia, on short leafless branches or warty tubercles of trunk or on larger branches, subglobose to pyriform, smooth, often lenticellate-verrucose; peduncle 3–12 mm long, stout, orifice plane or slightly sunken, closed by five to six apical bracts; internal bristles none; basal bracts 3, 1–2 m long, ovate-triangular, obtuse, persistent; flowers of unisexual, four kinds; male flowers near the mouth of receptacles, in two to three rings, sessile, much compressed; sepals three to four, dentate-lacerate, lobes jointed below, red, glabrous; stamens two, exserted; filaments 1 mm, connate below; anthers oblong, parallel; female flowers sessile or very shortly stalked among gall flowers; sepals 3–4, dentate-lacerate, lobes jointed below, red, glabrous, ovary superior, sessile or substipitate, red spotted; style 2–3 mm long, glabrous, simple; stigma clavate; gall flowers long stalked; ovary dark red, rough; style short. Syconium 2.5 × 2 cm, orange, pink, or dark crimson; achene granulate.

4.5.4 Organoleptography

Fruit is greenish when unripe pubescent, surface somewhat rough externally, with milky latex. Fracture is somewhat coarse, with rough texture. Taste is sweet. Fruit is globose to pyriform and 5–10 cm in diameter. Seeds are numerous, whitish in color and round.

4.5.5 Edible Potential

Parts used: fruit and milky latex

4.5.6 Edible and Medicinal Uses

Fruits are edible though they are usually of only local economic importance or eaten as bushfood. However, they are extremely important food resources for wildlife. Figs are of considerable cultural importance, both as objects of worship and for their many practical uses. The wood is often employed in making cart frames, plow box, fittings, match boxes, and cheap furniture. The tree is planted for shade in gardens. Fig trees have profoundly influenced culture through several religious traditions.

4.5.7 Medicinal Properties

The roots are commonly used in medicinal preparations. Fruits and leaves have astringent properties and are used in treating related ailments and various diseases/disorders including diabetes, liver disorders, diarrhea, inflammatory conditions, hemorrhoids, respiratory, and urinary diseases. *F. racemosa* is pharmacologically studied for various activities including antidiabetic, antipyretic, anti-inflammatory, antitussive, hepatoprotective, and antimicrobial activities. The latex of this plant is used to treat dysentery, diarrhea, piles, tooth decay, rheumatism, and skin diseases. White, milky juice extracted from the stems and leaves is used for removal of warts. Common fig is considered to be a laxative, emollient, expectorant, and analgesic. It is usually employed in preparations of laxative syrups, combined with Senna and carminatives.

4.5.8 Folk Preparations

(a) Dry (250 g) or fresh fruit (50 g) are boiled in water (500 mL) till 350 mL of water remaining. This decoction of the fruit (three to four tablespoons once at night) is used in cases of colds, soothing the mucous membranes of our respiratory tract.
(b) Fresh fig (20 g) can be used externally as an emollient poultice in treatment of boils and small tumors.
(c) Decoction of the bark (25–30 g boiled in 250 mL of water) is used as a wash for wounds.

(d) The bark of fig is said to have healing power. The bark is rubbed on a stone with water to make a paste and the paste is applied over the skin which is afflicted by boils or mosquito bites. Allow the paste to dry on the skin and reapply after a few hours. For people whose skin is especially sensitive to insect bites; this is a very simple home remedy.
(e) Dried fruit powder (20 g) is mixed with water (100 mL), and the paste produced is used for rheumatism, pimples, and freckles on face.

4.6 *Fragaria nubicola* Lindl. ex Lacaita

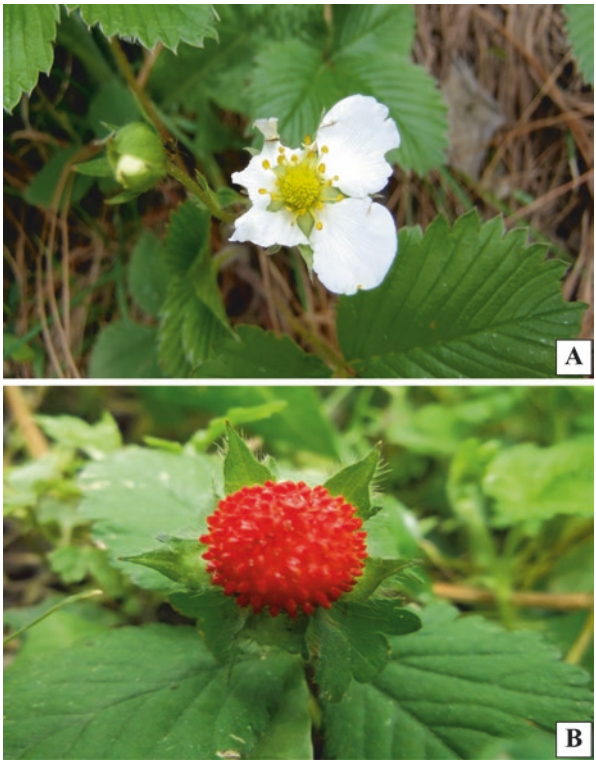

Fig. 4.6 *Fragaria nubicola* Lindl. ex Lacaita. (**a**) Flower (**b**) Ripened fruit

4.6.1 Systematic Studies

Botanical name	:	*Fragaria nubicola Lindl. Ex Lacaita*
Family	:	Rosaceae
Common name	:	Himalayan strawberry
Local name	:	Panjakha (Hindko)
Conservation status	:	Rare in the wild
Habit/habitat	:	Grows in shady wooded valleys, forest edge, and meadows on mountain slopes, open grassland at elevations of 1600–4000 m. Mostly found in woodland, dappled shade, shady edges, and grassy slopes
Blooming time	:	April to May
Fruiting period	:	June to July
Distribution		
World	:	Found in the Himalayas, from Pakistan to Burma, at altitudes of 1800–3800 m. Native to the temperate Asian region that extends from northern Afghanistan across the Himalayas to China and Japan and to the tropical Asian region of India and Southeast Asia. However, widely naturalized in North America and considered by some to be somewhat benign as a ground cover
Pakistan	:	Kashmir, Murree, Hazara, Balakot, Galliat, Thandiani, Abbottabad, Dir, Chitral, Swat, Gilgit, Hunza, Skardu

4.6.2 Ecology

Mostly require rich, neutral to alkaline soil in sun or partial shade. Suitable for light (sandy), medium (loamy), and heavy (clay) soils and prefers well-drained soil. Suitable pH is acid, neutral and basic (alkaline) soils. It can grow in semi-shade (light woodland) or no shade. It prefers moist soil. Plants deteriorate after a few years and need replacing, which can be done in spring. It is a good ground cover and grows well in a rock garden. It should not be grown with small plants as it will suffocate them but will be a good cover for bulbous plants.

4.6.3 Morphological Description

Plants are perennial herbs, stoloniferous, 4–25 cm tall. Stems are appressed white sericeous. Petiole is appressed (rarely spreading) white sericeous. Leaves are three-foliolate, lateral leaflets often distinctly petiolulate or sessile, elliptic or obovate, 1–5 × 0.5–2.5 cm, abaxially appressed, appearing silvery, sparsely so between veins, adaxially appressed pilose, base broadly cuneate or rounded, margin sharply incised serrate, apex obtuse. Inflorescence one to several flowered. Pedicels are

appressed white sericeous. Flowers are large, sometimes more than 2.5 cm in size. Epicalyx segments lanceolate, abaxially sparsely villous, margin entire to dentate, apex acuminate. Sepals are ovate-lanceolate or ovate-oblong, apex acuminate. Petals are white, obovate-elliptic, and slightly longer than sepals. Stamens 20 to numerous, narrow-cylindrical. Carpels are numerous, free. Aggregate fruit is ovoid, multiple, drupetum, fleshy, red, 0.7–2.5 cm in diameter, persistent sepals appressed to aggregate fruit. Achenes are red, prominent, ovoid, glabrous, or rugose, 1.5–2.5 mm in diameter.

4.6.4 Organoleptography

Fresh fruit is aggregate, greenish white as it develops and turns red when riped. Berries are ovoid in shape, glabrous, fleshy, and soft to touch. Fruits have very pleasant sweet strawberry flavor. Berries are 0.2–0.6 cm long, 0.1–0.2 cm wide, and 0.5–2.7 cm in diameter. Dried berries are dark red, have fruity smell, and have sweet taste. The fruit (epicarp, mesocarp, and endocarp) is distinct. Ten to fifteen fresh berries equals 3–6 g, while 25–30 dried berries weighed up to 2–4 g.

4.6.5 Edible Potential

Parts used: fruit and leaves

4.6.6 Edible and Medicinal Uses

Berries are edible, a very pleasant strawberry flavor gathered and sold by local children. Leaves are used as fodder for ruminants and a good ground cover plant, spreading quickly by means of runners. It is rather bare in winter though and should not be grown with small plants since it will drown them out. The leaves are also edible as a potherb—cooking is recommended.

The whole plant is anticoagulant, antiseptic, depurative, and febrifuge. It contains vitamin C, protein, phosphorus, potassium, calcium, magnesium, and iron. It can be used for rheumatic gout, sun burn, tongue sores, diarrhea, dysentery, and menstrual problems. Fresh leaves can be used in the treatment of swellings, boils and abscesses, weeping eczema, ringworm, stomatitis, laryngitis, acute tonsillitis, snake and insect bites, and traumatic injuries. The flower is used to activate the blood circulation. Even the fruit is singled out for its restorative properties, serving as a cure for various skin diseases.

4.6.7 Folk Preparations

(a) The unripe fruits (3–4) are chewed twice a day to treat blemishes on the tongue.
(b) The berries (5–8 fresh taken daily) are of great benefit for rheumatic gout.
(c) An infusion is made by boiling shade dried flowers (12–14) in one cup of water (250 mL). Half cup of this infusion (125 mL) is taken in the early morning to activate the blood circulation.
(d) Sunburn could be relieved by rubbing a cut strawberry (three times per day) over a freshly washed face.
(e) Fresh leaves (40–50 g) are boiled in water (1 L) and strained. The softened leaves are crushed and applied externally (twice a day) as a poultice in the treatment of boils and abscesses, weeping eczema, ringworm, etc.
(f) The extract (10–15 mL) obtained by crushing fresh leaves (50–60 g) is applied (three times per day) on wounds, burns, and swellings.
(g) Decoction is made by boiling equal amount of dried leaves and roots (25–30 g each boiled in 500 mL of water). Two to three tablespoons (6–9 mL) of this decoction along with one teaspoon of sugar is given three times per day to stop diarrhea and dysentery.
(h) The juice of the fresh fruit (150 mL/500 g) is taken early in the morning for the treatment of profuse menstruation.
(i) A tea made from the leaves (12–15 leaves boiled in one cup of water) can be used internally for digestive upsets, gout, acute tonsillitis, and as a gargle for sore throats.

4.7 *Myrsine africana* L.

Fig. 4.7 *Myrsine africana* L. (**a**) Inflorescence. (**b**) Fruit in field

4.7.1 Systematic Studies

Botanical name	:	*Myrsine africana* L.
Family	:	Myrsinaceae
Common name	:	Cape myrtle, African boxwood
Local name	:	Chapra (Urdu), Bebrang (Pashto), Khukan (Hindko)
Conservation status	:	Common in the wild
Habit/habitat	:	Small shrub (Hedge) growing naturally in forests, woodland, garden, sunny edge, dappled shade, arid stony places. Prefers shady places in the drier oak and rhododendron forests of the Himalayas to 2700 m
Blooming time	:	March to May
Fruiting period	:	July to September
Distribution		

Botanical name	:	*Myrsine africana* L.
World	:	*Myrsine africana* has a wide distribution from the Himalayas, Nepal, China, Pakistan, India, the Azores to eastern and southern Africa. It is indigenous to Macaronesia, Africa, and South Asia
Pakistan	:	Chitral, Swat, Buner, Marguzar, Hazara, Abbottabad, Rawalpindi, Murree Hills, Changla Gali, Azad Kashmir

4.7.2 Ecology

Myrsine africana is slow growing but long lived and certainly worth the patience to give it a place in the garden. It grows well in dry, semi-shade under trees, as well as in the full sun. It is suitable for light (sandy), medium (loamy), and heavy (clay) soils and prefers well-drained soil. Suitable pH is acidic, neutral, and basic (alkaline) soils. It can grow in semi-shade (light woodland) or no shade. It prefers moist soil. It is drought tolerant and hardy to about 20 °F. In the winter rainfall areas, plants should be planted in the winter to give the young plants the time to establish before the dry summer months. It is a very nice plant for small hedges. Birds love the fleshy fruits of *Myrsine africana*, helping to disperse the seed.

4.7.3 Morphological Description

The slow-growing, evergreen shrub with a rather stiff and upright shape when old can reach 50–100 cm high over time. From the few, woody, upright stems, many short and thinner side branches shoot, all pointing upward. Branchlets terete is 0.5–2 mm in diameter, reddish glandular granulose and puberulent, with capitate trichomes, often glabrescent. The small oval-shaped leaves are a glossy dark green color. Petiole marginate, 1–2.5 mm, strongly decurrent; leaf blade obovate to orbicular, 1–5 × 0.7–1.6 cm, papery or leathery, glabrous, minutely punctate abaxially, base cuneate, margin serrate, apex obtuse to rounded; lateral veins inconspicuous, marginal vein absent. Typical of this species, the upper half of the leaf edge is slightly cut with fine teeth. The older leaves are tough and leathery, whereas the new growth is soft with a lovely deep red color. Inflorescences axillary, subumbellate or fascicled; basal scales in one series. The cream-colored flowers formed in groups at the base of the leaves are very small, but interesting, as the male and female flowers are borne on separate plants. The male flowers with their much exserted red anthers are more conspicuous than the female flowers. Yellowish white flowers are 2–2.5 mm, tetramerous. Pedicel is 1–1.5 mm long, glabrous or glandular puberulent. Calyx four-lobed spreading, nearly free, broadly ovate to elliptic, 1–2 mm, flat, glabrous, margin entire, ciliate, apex acute to obtuse. Corolla 2–3 mm, united to at least one half length, glabrous outside, puberulent inside; lobes lanceolate, densely punctate, margin entire, glandular granulose, apex obtuse to acute. Stamens 4, longer than petals;

filaments united basally into a tube adnate to corolla tube, puberulent in staminate flowers. Pistil globose. Style short; stigma discoid, margin lobed. The female plants that are covered with the attractive pale blue or purple-colored, globose, smooth fruits after flowering. The fleshy, round fruits each with one seed, 3–4 mm in diameter, tipped by the style base are formed in abundance tight against the stem and remain on the plants for many months.

4.7.4 Organoleptography

Fruits are dark green in unripe condition while purplish red when riped. Axillary presence on branches is sweet to bitter, fleshy, drupe, globose berry like, rounded, 0.8–1.3 cm long, 0.4–1.5 cm wide and 1.4–2.5 cm circumference. Exocarp, mesocarp, and endocarp are distinct. Exocarp: purplish red, glabrous, smooth surface, sweet to bitter. Mesocarp: peel up clearly, pulp purplish white, pungent, and soft. Endocarp is externally brown, internally off-white, tasteless, and soft.

4.7.5 Edible Potential

Parts used: leaves, fruits, stem

4.7.6 Edible and Medicinal Uses

Myrsine africana has many interesting and different uses. It is a tough plant with attractive foliage and fruit, attracts birds and is suitable for most gardens as clipped into low hedges and features, tough enough for the waterwise garden. Plants are used for hedging in warm temperate zones. Ripe fruits are edible, also used as condiment, and are sold in market to make money. Leaves are used as fodder for cattle, goats, and sheep. Stems and branches are used in mud roofing hatching, and as fire wood. Ropes are also made from young elastic stem. The seed has sometimes occurred as an adulterant of powdered pepper.

4.7.7 Medicinal Properties

The plant is used to treat intestinal worms, skin diseases (pimples and allergy), and urinary disorders. It is also used to purify blood. The fruit is used as an anthelmintic, especially in the treatment of tape worm. It is also laxative and is used in the treatment of dropsy and colic. A gum obtained from the plant is used as a warming remedy in the treatment of dysentery and diarrhea.

4.7.8 Folk Preparations

(a) Fresh leaves (30–40 g) are boiled in two cups of water (500 mL) until half of the volume (250 mL i.e. 1 cup) remained. This decoction is strained and given 4–5 mL twice (two teaspoons) a day for the blood purification.
(b) Ripened fruits (30–40 g) are picked and dried under shade. Dried berries are ground into fine powder. Two teaspoons (7–9 g) of dried fruit powder is mixed with yogurt (40–50 g) and given once per day (night time) to the patient for expulsion of intestinal worms (tape worms).
(c) A paste is made by mixing dried stem powder (28–30 g) in diluted milk (10–15 mL). This paste is applied (at night) externally on the skin for 20–25 min to remove pimples.
(d) The gum (15–20 g) obtained from plant is mixed with honey (two teaspoons i.e. 4–6 g). One teaspoon (3–4 g) of this mixture is given twice a day to treat diarrhea and dysentery.

4.8 *Oxalis corniculata* L.

Fig. 4.8 *Oxalis corniculata* L. (**a**) Flower. (**b**) Fruit (Capsule)

4.8.1 Systematic Studies

Botanical name	:	*Oxalis corniculata* L.
Family	:	Oxalidaceae
Common name	:	Creeping wood sorrel, procumbent yellow-sorrel, sleeping beauty
Local name	:	Khatti booti (Urdu)
Conservation status	:	Very common in the wild
Habit/habitat	:	Occurs in agricultural areas, coastland, range/grasslands, ruderal/disturbed, urban areas, water courses, wetlands. Being cosmopolitan in its distribution and having high production in fertile seed, it can be found at home in gardens, lawns, arable land, and pastures. It is a common plant along roads and trails at elevations from near sea level to about 750 m
Blooming time	:	March to September
Fruiting period	:	September to November
Distribution		
World	:	Worldwide weed, with a known range including American Samoa, Anguilla, Australia, Canada, China, Pakistan, India, Afghanistan, Indonesia, Hawaii, Japan, New Zealand, United States of America
Pakistan	:	Peshawar, Kurram, Dir, Chitral, Swat, Gilgit, Balakot, Naran, Shogran, Murree, Hazara, Kashmir and plain areas of Punjab

4.8.2 Ecology

This species is cosmopolitan in its distribution, and its place of origin is unknown. It is regarded as weed in gardens, agricultural fields, and lawns. Spread of this species is due to high production of fertile seeds and its presence on all continents and many islands indicates that seeds are probably carried by birds. *O. corniculata* is thought to be invasive in many areas. Suitable for light (sandy), medium (loamy), and heavy (clay) soils and prefers well-drained soil. Suitable pH: acidic, neutral, and basic (alkaline) soils. It cannot grow in the shade. It prefers dry or moist soil.

4.8.3 Morphological Description

Plants caespitose or creeping herb, annuals, or short-lived perennials. Stems to 50 cm but often shorter, creeping, ascending to semierect, variably pubescent with appressed simple hairs. Rootstock a slender taproot, sometimes woody; stems several, freely rooting at nodes in contact with soil; stolons absent. Stipules small, rectangular to auriculate. Leaves alternate or pseudoverticillate;

petiole 1–13 cm; leaflet blades obcordate, broad, pilose-tomentose, 0.3–1.4 × 0.3–2.2 cm, green or suffused purplish red, variably adaxially and abaxially pubescent, apex deeply emarginate. Inflorescences axillary umbellate, 2–7 flowered are usually 3–8 cm long; peduncle usually slightly longer than petioles; bracts linear-lanceolate, 2–4. Pedicel 4–18 mm, deflexed or horizontal in fruit, densely strigose. Sepals 5, oblong-lanceolate, 3.5–5 × 1.2–2 mm, margin ciliate especially at apex. Petals 5, somewhat larger than the sepals, bright yellow, oblong-obovate, 6–8 × 3–4 mm. Filaments glabrous. Carpels 5, pubescent; styles longer than the shorter stamens. Capsule long cylindric, 1–2.8 cm long, five-sided, strigose with abundant simple hairs and a few septate hairs on dehiscence sutures. Seeds brown to brownish red, 5–14 per locule, ovoid-oblong, 1–1.5 × 0.8–1 mm, transversely ridged.

4.8.4 Organoleptography

Fruits are long cylindrical capsules or pods, grassy green in fresh form while dull green when dried. Numerous small hairs are present on fruit surface. Capsule has one end pointed while other having notched. Irregular vertical lines are present externally on fruit. 1–2.2 cm long, 0.1–0.3 cm wide, 0.4–0.6 cm diameter, sour taste and grassy smell. Internally capsule is greenish white in color, soft, enclosing many small grains like seeds. Seeds are dark brown, ovoid, 0.2–0.5 cm in size, ridges on external surface. Fruit is very light in weight, e.g., 40–50 capsules equals 4–5 g.

4.8.5 Edible Potential

Parts used: leaves, flowers

4.8.6 Edible and Medicinal Uses

The leaves of wood sorrel are quite edible; they are available all year round unless the winter is very cold having a pleasantly sour tangy taste of lemons. But they are very small and fiddly to harvest. They can be used as raw or cooked vegetable. They can be added to salads, cooked as a potherb with other milder flavored greens, or used to give a sour flavor to other foods. Raw flowers have a nice acid flavor and a pleasant addition to the salad bowl. A drink can be made by infusing the leaves in hot water for about 10 min, sweetening and then chilling. A slimy substance collects in the mouth when the leaves are chewed; this is used by magicians to protect the

mouth when they eat glass. Yellow, orange, and red to brown dyes are obtained from the flowers. The boiled whole plant yields a yellow dye.

4.8.7 Medicinal Properties

The entire plant is a good source of vitamin C and is used as an antiscorbutic in the treatment of scurvy. The whole plant is anthelmintic, antiphlogistic, astringent, depurative, diuretic, emmenagogue, febrifuge, lithontriptic, stomachic, and styptic. It is used in the treatment of influenza, fever, urinary tract infections, enteritis, diarrhea, muscular swellings, boils, pimples, traumatic injuries, sprains, and poisonous snake bites. It has also an antibacterial activity.

4.8.8 Folk Preparations

(a) The juice (15 mL) obtained by crushing fresh herb (80–100 g) is mixed with butter (5–7 g) and applied as poultice to muscular swellings, boils, and pimples. This practice is made once in a day preferably in night time (before sleeping).
(b) Dried herb (20 g) is boiled in two cups (500 mL) of water. This infusion (two teaspoon before night meal) is used as a wash to rid children of hookworms.
(c) Fresh leaves (18–20) are taken internally as an antidote to poisoning by the seeds of *Datura* spp., arsenic, and mercury
(d) Fresh leaves (50–60) are soaked in water (1000 mL) overnight and strained in the morning. This extract is applied (three times/day) to insect bites, burns, and skin eruptions.
(e) Two tablespoons of fresh leaf juice are given three times per day for the treatment of dysentery, piles, stomach acidity, peptic ulcer, and diarrhea.
(f) The fresh herb was collected (150 g) and crushed to obtain juice (25–30 mL). This juice is mixed with crushed onion (8–10 g) and applied externally to remove warts.

4.9 *Pistacia integerrima* J. L. Stewart ex Brandis

Fig. 4.9 *Pistacia integerrima* J. L. Stewart ex Brandis. (**a**) Inflorescence. (**b**) Fruiting branches

4.9.1 Systematic Studies

Botanical name	:	*Pistacia integerrima* J. L. Stewart ex Brandis
Family	:	Anacardiaceae
Common name	:	Pistacia galls/spogel seed
Local name	:	Kangar (Hindko), kakar singhi (Urdu)
Conservation status	:	Common in the wild
Habit/habitat	:	A dioecious tree shedding its leaves during the dry season and is wind pollinated. The species is occasionally found on exposed hilly slopes from 457–1980 m. Cultivated in the plains for its attractive foliage, which is bright red when young
Blooming time	:	March to May

Botanical name	:	*Pistacia integerrima* J. L. Stewart ex Brandis
Fruiting period	:	June to October
Distribution		
World	:	Native to Asia. Commonly found in East Afghanistan, Pakistan, India, North West and Western Himalaya to Kumaon
Pakistan	:	Baluchistan, Waziristan, Kurram, Dir, Chitral, Swat, Gilgit, Balakot Murree, Hazara, Kashmir and Salt range (Punjab)

4.9.2 Ecology

Pistacia integerrima is mainly Asiatic and shows a preference for dry slopes with shallow soils. The tree does not tolerate fire and is strongly susceptible to acidic soils. However it is wind firm, termite resistant, frost hardy and moderately drought resistant. It grows best in full sun, being intolerant of shade; it is the most frost-tolerant species of genus *Pistacia*, tolerating temperatures down to about −25 °C, yet it is most highly regarded in warm climates. Prefers well-drained deep soils and is tolerant to heavy clay soils. Management by pruning, lopping, and pollarding improves the tree form factor of *P. integerrima*. The seedlings are susceptible to strongly alkaline soils. This is a light demanding species. A nursery time of 12–18 months is recommended. It is an important species in riverbank stabilization and soil conservation. *P. integerrima* is a multipurpose tree of agroforestry interest and also used in wasteland afforestation programs.

4.9.3 Morphological Description

Pistacia integerrima is a multi-branched, single-stemmed, deciduous, and dioecious tree 17–25 m or more tall. Bark is dark brown. The tree has low/dense crown base and roots deeply. Petioles minutely pubescent, flattened above. Leaves large 16–25 cm long, pinnate frequently pari-or imparipinnate, papery, base oblique, margin entire, apex acuminate or long acuminate, on both sides minutely pubescent along midrib and lateral veins and with prominent venation. Leaflets opposite or subopposite, subsessile, 7–9 in number, long 80–140 × 20–35 mm, lanceolate, acuminate, glabrous, pale green on the undersurface. The terminal leaflet is much smaller than the lateral ones. Lateral nerves 14–20 pairs, arcuate. Flowers produced before leafing; inflorescence is red. Male inflorescence 6–7 cm, with clustered branches, female inflorescence 15–20 cm, rachis minutely pubescent; floral subtending bracts lanceolate, minutely pubescent. Pedicels minutely pubescent. Flowers unisexual, bracteate. Bracts ±1.2 mm long, lanceolate, apex pubescent. Bracteoles 2, linear, shorter. Male flowers with 2 lanceolate bracteoles and 2 linear-lanceolate sepals; stamens 3–5, anthers oblong. Female flowers with 2–4 linear-lanceolate bracteoles and 5 ovate or

oblong sepals; ovary globose, glabrous, stigmas thick, red. Drupe obovate-globose, slightly compressed, longitudinally striate in dried condition, apiculate, 5–6 mm in diameter, purplish or blue at maturity and with a bony endocarp.

4.9.4 Organoleptography

Unripe galls are dark green and become reddish violet when riped. Fruits are somewhat tasteless, axillary, succulent, fleshy, drupe, globular, 0.4–1.2 cm long, 0.2–0.9 cm wide, and 1.4–2.3 cm circumference. Exocarp, mesocarp, and endocarp are indistinct. Exocarp is violet, glabrous, rough and scaly, tasteless. Mesocarp is fused with exocarp. Endocarp is externally light brown, internally dark brown, light sweet, and hard. Dried fruits are dark violet, brittle, hard having rough texture and light in weight. It is 20–25 galls weighed up to 3–4 g.

4.9.5 Edible Potential

Parts used: bark, galls, and leaves

4.9.6 Edible and Medicinal Uses

Horticulturally, it is a popular choice for street trees in urban settings because it is very drought tolerant and can survive harsh environments. It provides considerable shade. It is used for improved soil as the leaves are used as green manure; grown as an ornamental, much appreciated for its crimson leaf color in the fall. Shoots and leaves used as medium-quality fodder. The oil from the seeds is used for biodiesel production. The wood is used for production of a yellow dye. Dyestuff is also obtained from insect galls, bark, and leaves. Healthy trees provide valuable wood for furniture. Fuel wood and charcoal are obtained from *P. integerrima*. Timber used in house construction, carving, furniture manufacture, farm implements, musical instruments, and thatching material. The timber can also be used in veneer and plywood manufacture. The essential oil obtained by steam distillation of kakar singhi is used in the preparation of indigenous drug. Young shoots and leaves are cooked and used as a vegetable. Roasted seeds are eaten or used in confectionery.

Often blackish irregular-shaped galls appear on the leaves and petioles, which are used in native medicine. *P. integerrima* have significant analgesic and anti-inflammatory activity. It is used widely as an herbal remedy for many ailments, including cough, asthma, bronchitis, fever, leprosy, ulcer, skin diseases, constipation, vomiting, dysentery, diarrhea, appetite loss, nose bleeding, snake bites, and scorpion stings. The plant extracts are used in treating livestock diseases.

4.9.7 Folk Preparations

(a) Powdered galls (18–24 g) are fried in ghee (4–5 g) and given half teaspoon (2 g) internally (three times a day) in dysentery.
(b) Stem bark (15–18 g) is boiled in water (500 mL) and filtered. This extract is cooled and half cup (125 mL) is given before breakfast for treatment of jaundice.
(c) Galls (40–50) are roasted and this ash is mixed with honey (3–5 g). One tablespoon (3 g) is given daily at night to cure whooping cough and asthma.
(d) Dried fruit (100 g) is mixed with equal amount of roasted wheat grains. This mixture is crushed along with sugar (40–50 g) in a grinding mill or machine. One tablespoon (4–5 g) is given twice a day (morning and evening times) with half cup of milk to cure leprosy.

4.10 *Prunus persica* (L.) Batsch

Fig. 4.10 *Prunus persica* (L.) Batsch. (**a**) Flower. (**b**) Fruiting branch

4.10.1 Systematic Studies

Botanical name	:	*Prunus persica* (L.) Batsch
Family	:	Rosaceae
Common name	:	Wild Peach
Local name	:	Jangli aaru (Urdu), shaltalo (Pashto)
Conservation status	:	Common in cultivated form
Habit/habitat	:	Commonly grow in woodland, garden, sunny edge, and shady place. Cultivated throughout the world, escaped from cultivation in waste fields or on disturbed slopes; 1500–2200 m
Blooming time	:	March to May
Fruiting period	:	July to August
Distribution		
World	:	A deciduous tree, native to Northwest and Northern China. Truly wild peaches no longer exist. They are important, fruit-bearing, and ornamental plants cultivated throughout temperate and subtropical zones (Southern Europe, Africa, Asia, and Australia)
Pakistan	:	Murree, Galliat, Abbottabad, Hazara, Peshawar, Dir, Chitral, Swat, Gilgit, Kashmir and plain areas of Punjab

4.10.2 Ecology

It requires a well-drained moisture retentive soil and prefers well-drained, moist soil. It can thrive in a loamy soil, doing well on limestone. Peaches do not grow well in acid soils. Prefers some chalk in the soil but it is apt to become chlorotic if too much is present. Preferred pH range is 6–7. Mostly succeeds in light shade but fruits better in a sunny position. The plant requires shelter from north and northeast winds and also from spring frosts. Peach is widely cultivated for its edible fruit in warm temperate areas and continental climates.

4.10.3 Morphological Description

Prunus persica is a tree, 4–10 m (13–33 ft) tall and 6 in. in diameter. Branchlets smooth, glabrous, lenticellate; current year's branchlets reddish on exposed side, greenish on shady side, shiny; previous year's branchlets reddish brown, squamose, with many lenticels. Petiole robust, 0.5–2 cm, with 2–8 nectaries; winter buds 2 or 3 in leaf axils, pubescent. The leaf blade is lanceolate, 7–16 cm (2.8–6.3 in.) long, 2–3 cm (0.79–1.2 in.) broad, pinnately veined, abaxially pilose in vein axils,

adaxially glabrous, base broadly cuneate to rounded, margin crenate with gland-tipped teeth, apex acuminate; secondary veins 12–14 on either side of mid vein. The flowers are produced in early spring before the leaves; they are solitary or paired, 2.5–3 cm in diameter. Pedicel is very short. Hypanthium shortly campanulate, outside green with a reddish tinge. Sepals ovate to ovate-oblong, outside pubescent. Petals 5, pink, suborbicular to oblong, 1.5–1.7 cm in diameter. Stamens many, unequal in length, shorter than petals. Ovary is pubescent. Style shorter than stamens. The fruit has yellow or whitish flesh, a delicate aroma, and a skin that is either velvety (peaches) or smooth (nectarines). Drupe is greenish white, rarely golden yellow, sometimes with a reddish tinge, compressed globose, rarely subglobose, 3.5–6 × 4.5–7.5 cm, pubescent, very rarely glabrous, occasionally slightly glaucous; mesocarp succulent, sour-sweet, fragrant, separating from endocarp, not splitting when ripe; endocarp flattened globose, rarely subglobose to broadly ellipsoid, compressed on both sides, surface longitudinally furrowed and very sparsely pitted, base subtruncate, apex long acuminate. The single, large seed is red brown, oval shaped, approximately 1.7–3.5 long, 1.3–3 cm wide and is surrounded by a wood-like husk. Seed bitter to slightly sweet.

4.10.4 Organoleptography

Unripe fruit is yellowish green and fully riped is yellow and reddish. Fresh fruit is relish sweet to sour, axillary, fleshy, drupe, oval, 5.3–7.7 cm long, 2.6–4.8 cm wide and 5.5–7.5 cm circumference. Exocarp, mesocarp, and endocarp are distinct. Exocarp (peel) is yellow, thin, sour, pubescent, rough, and furrowed surface. Mesocarp (fleshy pulp) peels up clearly, straw yellow, sour to sweet, and soft. Endocarp (seed) externally brown, oval in shape, internally light brown, bitter, woody hard, 1.3–3.4 cm long and 1.2–2.5 cm wide.

4.10.5 Edible Potential

Parts used: leaves, flower, root, fruit

4.10.6 Edible and Medicinal Uses

Fruit is edible, raw, cooked, or dried for later use. The fruit is often used in ice creams, pies, jams, chutneys, etc. When fully ripe, the fruit of the best forms are very juicy with a rich delicious flavor. Wild trees in the Himalayas yield about 36.5 kg of fruit a year. Fruits of the wild peach are richer in nutrients than the

cultivated forms. The fruit is a good source of vitamins. Flowers are also edible in raw or cooked forms, mostly added to salads or used as a garnish. They can also be brewed into a tea. The distilled flowers yield a white liquid which can be used to impart a flavor resembling the seed. Seed is used to add flavor if not too bitter. Semidrying oil is obtained from the seed. It is used as a substitute for almond oil in skin creams, perfumes, shampoos, face wash, etc. The seed contains up to 45% oil. A gum is obtained from the stem is used as an adhesive. It can also be used for chewing. Yellow and green dyes can be obtained from the leaves. A dark gray to green dye can be obtained from the fruit. The leaves, when rubbed within any container, will remove strong odors such as garlic or cloves so long as any grease has first been fully cleaned off. Leaves are used as fodder for cattle. Dried branches are used as firewood by local inhabitants.

The leaves are astringent, demulcent, diuretic, expectorant, febrifuge, laxative, parasiticide, and mildly sedative. They are used internally in the treatment of gastritis, whooping cough, coughs, and bronchitis. They also help to relieve vomiting and morning sickness during pregnancy, though the dose must be carefully monitored because of their diuretic action. The flowers are diuretic, sedative, and vermifuge. They are used internally in the treatment of constipation. A gum from the stems is alterative, astringent, demulcent, and sedative. The seed is antiasthmatic, emollient, hemolytic, laxative, and sedative. It is used internally in the treatment of constipation in the elderly, coughs, asthma, and menstrual disorders. The bark is demulcent, diuretic, expectorant, and sedative. It is used internally in the treatment of gastritis, whooping cough, coughs, and bronchitis. The root bark is used in the treatment of dropsy and jaundice. The bark is harvested from young trees in the spring and is dried for later use.

4.10.7 Folk Preparations

(a) The dried powdered leaves (20–30 g) are mixed with half cup of milk (150 mL). This mixture is applied externally as poultice (at night) to heal sores and wounds.
(b) Fresh flowers (10–12) are washed and blended with water (100 mL) and honey (3–5 g). The extract is filtered and two teaspoons (twice a day) are given to treat constipation.
(c) De-shelled seeds (30–40) are coarsely ground with sugar (8–10 g) and boiled in two cups of water (500 mL) until half of the water remained. This decoction is filtered and given (50 mL) at night time to treat whooping coughs and asthma.
(d) A tea made from root bark (8–12 g boiled in 500 mL water) of young tree is used in the treatment of jaundice and gastritis.
(e) Fresh fruit pulp (10–15 g) is applied externally on the washed face for skin freshness and to remove scars. Eating fresh fruit (twice a day) may improve blood hemoglobin level.

4.11 *Punica granatum* L.

Fig. 4.11 *Punica granatum* L. (**a**) Inflorescence. (**b**) Fruiting in natural habitat

4.11.1 Systematic Studies

Botanical name	:	*Punica granatum* L.
Family	:	Punicaceae
Common name	:	Wild pomegranate
Local name	:	Pomegranate (English), anar (Urdu, Punjabi), daruna, daruni (Hindko)
Conservation status	:	Common in the wild
Habit/habitat	:	Grows wild from 1000–2000 m. Woodland Garden Sunny Edge
Blooming time	:	April to July
Fruiting period	:	September to December
Distribution		
World	:	Mediterranean Europe, Africa, China, Pakistan, India, Afghanistan, Iran, Bhutan, Bangladesh
Pakistan	:	Baluchistan, Waziristan, Khyber Pakhtunkhwa, Kurram, Dir, Chitral, Hazara, Kashmir, and Salt range

4.11.2 Ecology

It is hardy subtropical species and surviving between winter temperatures (−10 °C). The best quality fruits are produced in areas with cool winters and hot, dry summers. It does not fruit well in very humid climates. Under dry conditions, irrigation is needed to sustain high yield levels. The tree can tolerate soils on which most fruit crops do not thrive including calcareous and alkaline soils. In Southeast Asia, the tree grows well up to 1600 m elevation on a wide range of soil types. In water regions, the tree becomes evergreen, flowering and fruiting become protected and fruit quality is inferior.

4.11.3 Morphological Description

An erect deciduous spreading shrub or tree, 8–12 m high; stern is woody and thorny; wood is very hard and light yellow, branches and branchlets four-angled, becoming terete with age, often terminating as indurate spines. Petiole 3–10 mm; leaf blade adaxially shiny, lanceolate, elliptic-oblanceolate, or oblong, 2–8 × 1–1.5 cm, base attenuate, apex obtuse or mucronate. Leaves shed in December, new light red leaves appearing in the middle of March, new growth, very ornamental. Leaves, opposite, lanceolate, shining from above, 5.7 cm long, 1.7 cm broad, having entire margin; petiole, thin, 4 cm long; leaves, often clustered on arrested branchlets. Flowers, sessile, ebracteate, complete, actinomorphic, bisexual, solitary, or in axillary clusters of 2–6; calyx, actinomorphic, persistent, thick, fleshy, 3–5 cm in diameter; corolla, polypetalous, with six petals, caducous, actinomorphic; androecium, with numerous stamens, inserted at different levels below the petals, polyandrous. Floral tube red-orange or pale yellow, campanulate-urceolate, 3–3.5 × 2–2.5 cm; sepals 5–9, erect, deltate. Petals 5–9, bright red-orange, obovate, 1–2.5 × 1–1.5 cm, apex rounded, or obtuse. Stamens numerous, included to exserted. Ovary 9–12-loculed, in two- or three-superposed layers, lower locules with axile placentation, upper ones with apparent parietal placentation. Fruits are globular, crowned by a persistent calyx, possessing a hard outer rind diameter, 4–7 cm; color is yellowish green with a red tinge. Seeds, angular, with a fleshy aril which constitutes the edible part; color, varying from red to pinkish white.

4.11.4 Organoleptography

The dried fruit is globose pome, shiny, and rough in texture. Externally fruit ball is reddish brown in color, and the rind is bitter in taste. The rind of fruit is hard, inodorous, externally brown while internally yellowish brown with ridges and furrows. Dried seeds enclosed in pulp are red in color sometimes reddish white. They have fruity smell and sour in taste. The seeds are pyramidal in shape having smooth external surface. The fruit (endocarp, mesocarp, epicarp) is indistinct.

4.11.5 Edible Potential

Parts used: fruit, rind, seeds, root bark

4.11.6 Edible and Medicinal Uses

The fruit is delicious to eat. The major use of wild pomegranate is for the making of *anardana*, which is used in making *chutney* and as a souring agent in various preparations. Dried seeds are used for adding taste to certain foods. A red dye is obtained from the flowers and also from the rind of unripened fruits. The dye can be red or black, and it is also used as an ink. It is coppery-brown in color. No mordant is required. The dried rind yields a fast yellow dye, which is used for dying cloth and for making a hair dye. Fruit rind and root bark contained tannins which could be used for tanning and dying leather and also making jet-black ink. The dried peel of the fruit contains about 26% tannin. Plants are grown as hedges in Mediterranean climates. The wood of the tree is very hard and durable. It is generally used in making agricultural implements. Leaves are used as fodder for goats and sheep.

The leaves, bark, root bark, flowers, and fruit are used medicinally. The juice of fresh leaves is given in dysentery, as a styptic for the checking of bleeding from nose. A decoction of the leaves is useful as eyewash as well as for diseases of the buccal cavity. The bark of stem and roots is used as anthelmintic. The root bark is effective for the treatment of leucorrhoea, hemorrhage, and tuberculosis disease of children. The flowers and flower buds are used as styptic, astringent, and tonic. They are used for the treatment of leucorrhoea, blennorrhea, chronic diarrhea, dysentery, bronchitis, etc. The fruit is valued as a stomachic and refrigerant. The juice of fruit is given in typhus, gastric pain, asthmatic fever, inflammation of urinary tract, ophthalmia, and hemorrhage. The bark and fruit are used for snake bite.

4.11.7 Folk Preparations

(a) Dried flowers (250 g) are boiled in water (500 mL) with sugar (150 g) till 350 mL of water remaining. This mixture is filtered by muslin cloth and two to three teaspoons (20 mL) is given (two to three times/day) to patient suffering from stomach, liver, and intestinal inflammation.
(b) Dried rind powder (250 g) is mixed with sugar (150 g) and one teaspoon (5 g) is given with 1 cup (100 mL) water to the patient suffering from diarrhea, dysentery, piles, diabetes, and stomach disorders.

(c) Dried rind powder (3–5 g) is crushed under teeth daily at night for mouth gums, whooping cough and toothache. For gum bleeding and bleeding of the teeth, the fruit rind powder (10 g) is mixed with powdered black pepper (2 g) and common salt (1 g) and applied. Such preparation is useful for teeth whitening and strengthens gum.
(d) The bark decoction (20 g dried powder boiled in 200 mL water until water remained one third and filtered) is very effective for bleeding piles.
(e) The pomegranate leaves and sandal wood powder (3 g dry weight each) mixed with one tablespoon of curd is taken with a sip of honey for threatened abortion.
(f) A paste of the leaves (20 g powder mixed in 10 mL of water) is applied on the red part of the eye and damaged skin (eczema) to remove itching. This is also beneficial for ringworm.

4.12 *Rubus fruticosus* L.

Fig. 4.12 *Rubus fruticosus* L. (**a**) Flower. (**b**) Fruiting branch

4.12.1 Systematic Studies

Botanical name	:	*Rubus fruticosus* L.
Family	:	Rosaceae
Common name	:	Blackberry, holly bramble
Local name	:	Karwara, goraj (Pashto)
Conservation status	:	Growing in wild but becoming rare
Habit/Habitat	:	A prickly shrub. It is found on waste, cold places in fertile loamy soil of forest tracts especially in *Pinus roxburghii*
Blooming time	:	April to September and June and October
Fruiting period	:	October and December
Distribution		
World	:	The plant found in temperate climates and native of Central Asian including Afghanistan, Iraq, Israel, Pakistan, and also native to Europe. It is distributed at 3500–6000 ft
Pakistan	:	Baluchistan, Khawaja Amran range and near Chhapar, Kurram, Chitral, Lower Swat, Gilgit, Hunza, Nagar, Lower Hazara, Common, Punjab, Murree, Hassan Abdal, Salt range, Poonch, Kashmir

4.12.2 Ecology

One- to two-meter tall shrub with a prostrate stem found in humid habitats, scrubby vegetation, along riverbanks, woodlands coastal plains, shrub lands. Suitable for light (sandy), medium (loamy), and heavy (clay) soils, prefers well-drained soil, and can grow in nutritionally poor soil. Suitable pH is acidic, neutral, and basic (alkaline) soils and can grow in very acidic and very alkaline soils.

It can grow in full shade (deep woodland), semi-shade (light woodland), or no shade. It prefers moist soil and can tolerate drought. The plant can tolerate strong winds but not maritime exposure.

4.12.3 Morphological Description

Blackberry is a perennial, semideciduous, 1–2 m, prickly, erect or semiprostrate shrub with arching stem and complex branches armed with hooked thorns. Leaves 3.8–3.2 cm long and 0.3–0.9 cm broad, alternate, compound having three or five short-stalked oval or elliptical leaflets with toothed edges dentate or serrate. Leaflets coriaceous, dark green and glabrous above, whitish gray beneath covered with minute and short prickles. Stipules are small and filiform. Flowers present on panicles, actinomorphic, complete, perfect, petals five in number, pink and violet in color.

Stamens numerous and ovary perigynous. Fruit berry 1–2 cm in diameter, composed of aggregate of fleshy segments each called as drupelet. Fruit changes its color from green to red and finally black upon ripening. Seeds oval, dark brown, 1–3 mm long and irregularly pitted. Branches robust and leaves beneath hairy with white stellate tomentum, prickles short-scattered hooked, leaflets orbicular obovate or elliptic obtuse or acute, stipules setaceous, flower thyroid terminal panicles, calyx lobes short acute reflexed in fruit, carpels quite glabrous. Stem arched obtusely angled, channeled; prickles stout. Leaflets sometime 5 at the base of the stem, 1–2 in. coriaceous, sometimes abruptly acuminate; petiole 0.5–1 in., flattened above; stipules subulate, velvety. Panicles 6–10 in.; branches short, very shout, densely tomentose; pedicles stout, short, bracts often toothed or laciniate. Flowers, lobes wooly on both surfaces, sharply reflexed in fruit, petals obovate, pink stamens very numerous, in many series. Fruit small, globose, drupes many, fleshy; black; receptacle deciduous, stone pitted.

4.12.4 Organoleptography

The dried fruit is spherical, circular, greenish brown in color, fruit surface hairy, sweet in taste, odorless, diameter of fruit ranges from 1.5 to 2 cm and length varies from 0.3 to 1.2 cm. Fruit consist of aggregates of drupelets which are compactly arranged. This arrangement is also seen internally in the fruit. Internal color of fruit varies from green to yellow with irregular hairs. Each drupelet pointed at the base and broad at the apex. Weight of 15 fruits is nearly equal to 3.4 g.

4.12.5 Edible Potential

Parts used: fruit, leaves

4.12.6 Edible and Medicinal Uses

Fruit is edible, used to make drinks and wine. Leaves are rich in tannins. Used as a hedge plant. The fruits are made into juice and are also eaten. Also used as a fodder. Leaves are used as fodder for cattle. A purple to dull blue dye is obtained from the fruit. A fiber is obtained from the stem and used to make twine.

Old leaves are used in the treatment of diarrhea, cough, reducing fevers and as diuretic and aphrodisiac. The root bark and the leaves are strongly astringent, depurative, diuretic, and tonic. They make an excellent remedy for dysentery, diarrhea, hemorrhoids, and cystitis. Roots and leaves treat skin problems. Fruits are edible and are used as carminative.

4.12.7 Folk Preparations

(a) Leaves (10–15) are boiled in one and a half cup of water (375 mL) to make an infusion. Half cup of this infusion is taken (twice a day) to stop diarrhea and for bleeding.
(b) The young leaves (40–45 g) are crushed, squeezed, and applied externally used for urticaria.
(c) Dried and crushed young shoots of plant (20–25 g) have been applied on wounds, infected insect bites and pimples.
(d) Extracts of leaves and roots (four to five tablespoons in morning time) have been used for the treatment of diabetes mellitus, rheumatism, sore throat, hemorrhoid, and diarrhea.
(e) The infusion of dried leaves (30–40 g/L water) is used (half cup once daily at night) for relaxing uterus muscles and painful periods to women. It is also given in bowel complaints.
(f) Dried root (8–10 g) is boiled in two cups of water (500 mL). Three to four tablespoons of this decoction two times per day is useful in dysentery, relaxed bowels, and whooping cough.

4.13 *Sageretia thea* (Osbeck) M. C. Johnst

Fig. 4.13 *Sageretia thea* (Osbeck) M. C. Johnst. (**a**) Inflorescence. (**b**) Ripened fruit

4.13.1 Systematic Studies

Botanical name	:	*Sageretia thea* (Osbeck) M. C. Johnst
Family	:	Rhamnaceae
Common name	:	Chinese sweet plum, poor man's tea, Mock buckthorn
Local name	:	Dhamman (Punjabi), ganger (Hindko)
Conservation status	:	Common in the wild
Habit/habitat	:	Deciduous shrub or small tree mostly found in mountain forests and hills below elevation of 2100 m
Blooming time	:	July to September
Fruiting period	:	March to May
Distribution	:	
World	:	It is a tropical plant native to various regions of Asia including India, Japan, Korea, Thailand, Vietnam, and China and also found in warmer areas of North America
Pakistan	:	Sindh, Baluchistan, Thal-khurram, Chitral, Guirat, Swat, Gilgit, Hazara, Kagan, Poonch, Kashmir, Jhelum

4.13.2 Ecology

Altitudinal range from near sea level to 1000 m. It usually grows in well-developed upland rain forest particularly the drier more seasonal forests.

4.13.3 Morphological Description

Deciduous shrub or small tree 3–5 m tall. Bark grayish brown in color, covered with scales, becomes multicolored when tree becomes old. Branchlets terminate in a spine. Leaves alternate to opposite, small, green above, light yellow below, Leaves: ovate or elliptic, entire, about 2–2.5 cm long and 1.8–2 cm wide, adaxial surface glabrous, tomentose, elliptical-ovate to oblong, apex acute, base rounded, entire or minutely serrate, stipule present, very minute. Leaf venation: reticulate, apex acute, midrib more prominent on abaxial surface. Flowers are yellow, minute, fragrant, nearly sessile or having small pedicle, axillary or terminal spike. Calyx tubular, larger than corolla, lobes triangular-ovate, corolla spatula shaped. Style short. Calyx saucer shaped, 1.8 mm long, ovate. Petals obovate, 1.5 mm long. Petiole 3–8 mm leaf blade oblong, abaxially glabrous or pubescent veins, base rounded, glabrous, or tomentose. Fruit is a small drupe enclosing three small seeds. Purplish black or brown in color at maturity and sweet in taste. Seeds are soft and can be easily chewed along with the fruit. The weight of 10–15 fruits varied from 2.7 to 4.7 g.

4.13.4 Organoleptic Studies

The fully ripened fresh fruit are blackish brown rounded to subglobose with smooth, shiny outer surface and are sweet in taste. Dried fruits are hard, elliptic with irregular ridges on the outer surface. The dried fruits are odorless less and tasteless. The size of fruits ranged from 0.1 to 0.3 cm. The diameter of dried fruit ranges from 0.2 to 0.4. Internally the fruit is yellow in color and divided into four to five segments. Three seeds are found to be embedded in the fruit pulp and are microscopic.

4.13.5 Ethnobotanical Data

Voucher specimen # : 66
Parts used : fruit, leaves, roots

4.13.6 Local Uses

Leaves are used as fodder for cattle, goats, and sheep. Fruits are edible. The branches are used in mud roof thatching and as firewood.

Diseases cured cough, asthma, jaundice, diarrhea, skin diseases, kidney stone, and general body weakness. The root extract is used as cooling agent in jaundice Decoction of leaves is used as stimulant, also used as blood purifier.

4.13.7 Folk Preparations

(a) Two kg fresh roots are boiled in 7–8 L of water for 2–3 h. When 2 L of water is left, then it is filtered by cloth, stored in a glass bottle, and is given to the patient suffering from cough, asthma, jaundice, kidney stone, and body weakness. For children 5–15 years, half cup (16 mL) of decoction (at one time) is mixed in one cup (120 mL) of water and is given two times (morning and evening) per day for 7–8 days. For adults (16–60 years), one cup (120 mL) of decoction (at one time) is mixed in one glass (250 mL) of water and is given two times (morning and evening) per day for 8–10 days.
(b) About 120 g dried leaves and roots are ground together for 8–10 min. This powder is stored in glass or plastic bottle and is given to the patient suffering from diarrhea, dysentery, and skin diseases. For children (5–15 years), half teaspoonful (3–4 g) of powdered drug (at one time) is given with one cup of water (120 mL) two to three times per day for 3–4 days. For adults (16–60 years), one teaspoonful (6–8 g) of powdered drug (at one time) is given with one glass (250 mL) of water for 5–6 days.

(c) The extract is made by blending 15–20 g root in 40–50 mL water. Two tablespoons (10–15 mL) of root extract is used (in early morning) as cooling agent in jaundice.

4.14 *Solanum nigrum* L.

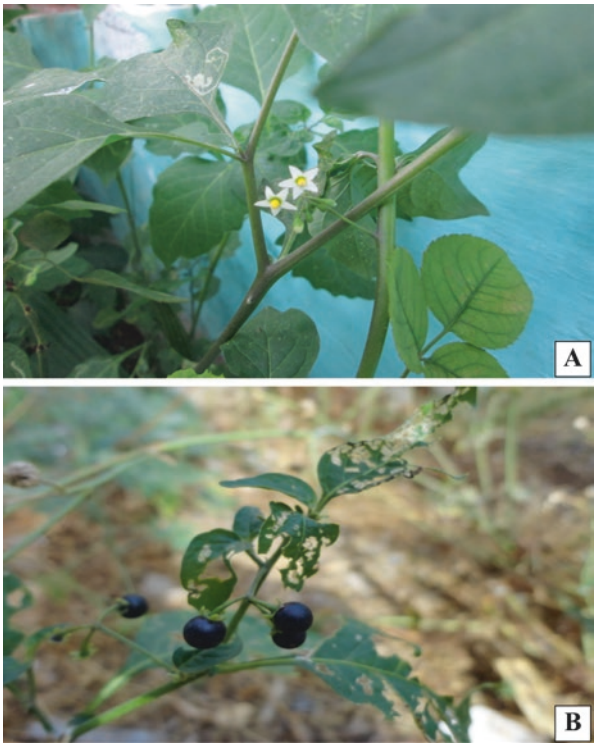

Fig. 4.14 *Solanum nigrum*. (**a**) Flowering branch. (**b**) Fruiting in natural habitat

4.14.1 Systematic Studies

Botanical name	:	*Solanum nigrum* L.
Family	:	Solanaceae
Common name	:	Black nightshade, garden nightshade, hound's berry, petty morel, wonder berry
Local name	:	Mako (Urdu), Kach-Mach (Punjabi)
Conservation status	:	Common in the wild
Habit/habitat	:	Black nightshade is a fairly common herb or short-lived perennial shrub, found in many wooded areas, as well as disturbed habitats like uncultivated and wasteland. It is a common garden weed

Botanical name	:	*Solanum nigrum* L.
Blooming time	:	July to September
Fruiting period	:	August to October
Distribution		
World	:	Native to Eurasia and introduced in the Americas, Australasia, and South Africa. Widely distributed in temperate Asia, Europe, India, Japan, and Taiwan. A common weed grows from 600 to 3000 m
Pakistan	:	Kurram, Dir, Chitral, Swat, Buner, Gilgit, Balakot Murree, Hazara, Abbottabad, Haripur, Peshawar Kashmir, and plain areas of Punjab (Rawalpindi, Chakwal, Jhelum)

4.14.2 Ecology

It is frequently to be seen by the wayside and is often found on rubbish heaps, but also among growing crops and in damp and shady places. Suitable for medium (loamy) and heavy (clay) soils and prefers well-drained, basic (alkaline) soils. It cannot grow in the shade. It prefers dry or moist soil. Flowers are formed on the old wood. It is very tolerant of dry conditions. Caterpillars and slugs are particularly fond of this plant and can totally destroy it. It grows well with clover; does not grow well with wormwood or white mustard and, when these plants are growing close to black nightshade, they increase its content of toxic alkaloids.

4.14.3 Morphological Description

Herbs annual, erect, 25–100 cm, pubescent with simple hairs, Unarmed, with a suffrutescent base. Stems often angular, subglabrous or pubescent to glandular-villous; hairs appressed or patent sometimes sparsely pubescent. Petiole 2–5 cm; leaf blade ovate, 4–10 × 3–7 cm, glabrous to puberulous-pubescent or glandular, base cuneate, decurrent, entire or coarsely dentate, sinuate to irregularly dentate, apex obtuse, Lamina decurrent. Petiole 8–40 mm long, appressed pubescent or glandular. Inflorescences extra-axillary umbels; peduncle 2–4 cm, exceeding or shorter than the pedicel length. Pedicel 0.8–1.2 cm. Calyx cup-shaped, 2–3 × 2–3 mm; lobes subdeltate, 0.5–1 × 1–1.5 mm, glabrous to pubescent abaxially, ciliate. Corolla white, 8–10 mm; lobes ovate-oblong, 4–5 × 3–3.5 mm, much exceeding the calyx in length, pubescent abaxially, ciliate, spreading. Filaments as long or shorter than the anthers, pilose, 1–1.5 mm; anthers oblong, 2.5–3.5 mm, yellow, dehiscing by 2 apical pores. Style 5–6 mm, pubescent at the base. Stigma capitate. Ovary glabrous. Fruiting pedicel strongly deflexed; fruiting calyx applied to berry. Berry dull black or orange-red, globose to subovoid, 8–10 mm in diam. Seeds discoid, minutely reticulate-foveolate, 2 mm in diameter.

4.14.4 Organoleptography

Fruits are green when unripe and black or red when fully riped. Fruit is spherical or globose in shape with fleshy, soft, smooth, and shiny appearance. Dried fruits are dark brown, acrid taste, 0.5–1 cm long, 0.1–0.3 cm wide, and 0.7–1.6 cm in diameter. Internally fruit is light brown enclosing disclike seeds of 0.1–0.4 cm diameter.

4.14.5 Edible Potential

Parts used: leaves, fruit, roots

4.14.6 Edible and Medicinal Uses

Solanum nigrum has been widely used as a food since early times, and the fruit was recorded as a famine food in fifteenth century. The ripe berries are edible. They are also used in preserves, jams, and pies having a pleasant musky taste. Thoroughly boiled leaves of edible strains are eaten as vegetable. Young leaves and new shoots—raw or cooked as a potherb or added to soup.

The *solanum nigrum* is a widely used plant in oriental medicine where it is considered to be antiseptic, hepatoprotective, diaphoretic, diuretic, emollient, febrifuge, narcotic, purgative, and sedative. It is harvested in the autumn when both flowers and fruit are upon the plant and is dried for later use. The leaves, stems, and roots are used externally in the treatment of cancerous sores, boils, leukoderma, and wounds. Extracts of the plant are analgesic, antispasmodic, anti-inflammatory, and vasodilator. The juice of the fruit has been used as an analgesic for toothaches. The juice of the plant is used on ulcers and other skin diseases. The fruits are used as a tonic, laxative, appetite stimulant; and also for treating asthma. Traditionally, the plant was used to treat tuberculosis. Black nightshade is used for skin diseases, rheumatism, and gout. Juice of the herb is given in chronic enlargement of the liver. It can cure ear and eye diseases. It is sometimes prescribed to remove the effect of old age.

4.14.7 Folk Preparations

(a) Equal amount of leaves, stems, and roots (18–20 g each) of fresh plant are crushed and used externally as a poultice or wash in the treatment of cancerous sores, boils, and wounds.
(b) The juice of the fresh fruit has been extracted (8–10 mL/40–50 g fruit) and applied on teeth (in morning) as an analgesic for toothaches.

(c) Juice of fresh leaves obtained by blending leaves (40–45 g) in half cup of water (125 mL) is given twice a day (3–4 teaspoons) to treat dysentery, diarrhea, and stomach complaints.
(d) Fresh leaves and berries (40–50 each) are boiled in three cups of water (750 mL) and six tablespoons of sugar (30 g) for 15–20 min. This decoction is filtered and one third cup (40–45 mL) is given in early morning to alleviate liver-related ailments including jaundice.
(e) Fresh leaves (2–3) when chewed and kept in mouth for some time help to heal mouth ulcers.
(f) A quarter cup (200 mL) of fresh leaves juice taken thrice a day for the duration of the periods, relieves painful periods.
(g) Dried berries and flowers (15 g each) are boiled in half liter of water (500 mL) and four tablespoons of honey (20–25 g) for 20–25 min. This decoction is given (40–50 mL two times per day) in cough and fever.

4.15 *Solanum surattense* Burm. f.

Fig. 4.15 *Solanum surattense* Burm. f. (**a**) Flowering branch. (**b**) Ripened fruit

4.15.1 Systematic Studies

Botanical name	:	*Solanum surattense* Burm. f.
Family	:	Solanaceae
Common name	:	Kantakari/yellow-berried nightshade
Local name	:	Kundiari (Urdu), mohkri (Punjabi)
Conservation status	:	Common in the wild
Habit/habitat	:	A prostrate herb, plains from the coast to 100 m. Throughout much of the country up to 1300 m
Blooming time	:	March to April
Fruiting period	:	May to July
Distribution		
World	:	Found in Southeast Asia, Malaya, and tropical Australia. Very commonly found throughout Indian Himalayas in plains from seashore to hills up to 1000 m high
Pakistan	:	In plains of Punjab, Peshawar, Kashmir, Murree, Hazara, Kaghan, Poonch, Malakand, Swat, Gilgit, Baltistan, Siran valley

4.15.2 Ecology

Yellow-berried nightshade occupies a great number of different ecosystems, from deserts to rainforests, and it is often found in the secondary vegetation that colonizes disturbed areas. This species has larger ecological amplitude and is found flourishing in sandy, gravelly, or even in saline habitats. It is a deep-rooted mesomorphic xerophyte having no definite photoperiod requirements in the field, as the plants flower and fruit throughout the year but dominantly in winter when nights are longer (14–15 h) than the day (9–10 h).

4.15.3 Morphological Description

It is a very prostrate, diffused prickly perennial herb somewhat with woody base up to 15 mm long. Stem yellow branched much and younger ones clothed with dense, stellate, and tomentose hairs. Prickles are compressed straight, glabrous, and shining, often 1–3 cm long. Leaves ovate or elliptic, sinuate or subpinnatifid, obtuse or subacute, stellately hairy on both sides, armed on the midrib and often on the nerves with long yellow sharp prickles, dark green above. Petiole is long, stellately hairy, and prickly. Flowers are in cymes or sometimes reduced as solitary. Calyx tube is

short, globose and lobes linear-lanceolate, acute, densely hairy and prickly. Calyx lobes 3–6 mm long. Corolla purple, lobes deltoid, acute, and hairy outside. Corolla limb 2–5 cm broad; lobes 8–15 mm long. Anther filament is long and glabrous, and anthers open by a pore. Ovary is ovoid and glabrous. Berry yellow, green-blotched, globose, 15–30 mm and surrounded by enlarged calyx. Seeds are glabrous, discoid, smooth to faintly reticulate.

4.15.4 Organoleptography

Berries are green with white patches in unripe condition while pleasant yellow when riped. Fresh fruits are globose, shiny, smooth, pungent odor, and bitter in taste. Dried fruits have wrinkled surface, yellow, bitter, odorless. Peel is internally brownish white having granular surface. Internally fruit is golden brown in color having minute grains like pulp forming a compact spherical structure. Fruit is 1.5–3.5 cm long, 0.8–1.6 cm wide, and 1.4–3.9 cm in diameter. Seeds are disclike, smooth, light brown, bitter but odorless. Size of seed is 0.1–0.4 cm. Ten dried fruits equals 2–4 g, light in weight.

4.15.5 Edible Potential

Parts used: whole plant specially fruits

4.15.6 Edible and Medicinal

The fruits are used for the preparation of curry. The root is used for snake and scorpion bite. Its dried fruit is used in making cigarettes. The smoke from these cigarettes is held in the mouth cavity, to treat dental infections. When smoked like tobacco, the natives believed that the smoke killed the insects, which they assumed caused the pain. The root paste is mixed with lemon and applied on snake and scorpion bites.

The plant parts are medicinal, being used variously as an expectorant (root), for sore throat (berries), asthma (seeds), headache (fruit) and to relieve local pain (leaves). Stem, flowers, and fruits are astringent, anthelmintic, pungent, bitter, and carminative. Yellow-berried nightshade facilitates the treatment of gastrointestinal disorders like constipation and flatulence because of its laxative and carminative properties. The plant is credited with diuretic properties and is used to cure dropsy. The herb is helpful in treating respiratory disorders like bronchial asthma, chest

pain, sore throat, cough, and bronchitis. It forms a constituent of herbal cough remedy Koflet (Himalaya) and is reported to promote expectoration. Its seeds are helpful for treating irregular menstruation in females. The herb is beneficial in the treatment of cardiac diseases, since it is a stimulant to the heart and a blood purifier.

4.15.7 Folk Preparations

(a) Boil 8–10 g of the fresh or shadow dried leaves of the plant; boil them in water (500 mL) until the color of water changes to greenish or yellowish. Take half cup (125 mL) of that water twice a day to cure chronic fever.
(b) Make powder of the whole plant and apply that powder (4–5 g) twice a day on the skin to treat infectious area.
(c) Take 200 g of ground whole plant and make a paste by adding 50–80 mL of water. Apply the paste over chest and forehead. Repeat the practice for 3 days only to treat chest congestion.
(d) The curry made from fruits (20 berries in 250 mL water) is given once in a weak for the treatment of backache and fever.
(e) The root bark (45 g) is soaked in water (1 L) for whole night and extracted in the next morning. This aqueous extract (20 mL) is given twice daily for the treatment of kidney stone and backache.
(f) The powder of dried yellow fruit (1 teaspoon) is taken daily with water (250 mL) before breakfast for diabetes.
(g) The fine powder of fruit (3–4 g) with honey (1 tablespoon) is given to children to treat chronic coughs and sore throat.
(h) The aqueous juice of seeds (3 mL) mixed with ginger (1 g) is given in fever.
(i) The fresh leaves (20–30 g) are crushed and mixed with black pepper (3–5 g). This paste is applied in night time externally on rheumatic joints.

4.16 *Viburnum grandiflorum* Wall. ex DC

Fig. 4.16 *Viburnum grandiflorum* Wall. ex DC. (**a**) Inflorescence. (**b**) Fruiting branch

4.16.1 Systematic Studies

Botanical name	:	*Viburnum grandiflorum* Wall. ex DC
Family	:	Caprifoliaceae
Common name	:	Himalayan viburnum, flowering viburnum
Local name	:	Guch, ikloon (Hindko)
Conservation status	:	Common wild in moist temperate forests, specially abundant in semi-shady and open places
Habit/habitat	:	Open forests and shrubberies, often forming dense scrub, 2700–3600 m in the Himalayas
Blooming time	:	April to May
Fruiting period	:	July to September
Distribution		

Botanical name	:	*Viburnum grandiflorum* Wall. ex DC
World	:	Common shrub in East Asia, China, and Himalayas. Distributed in New Jersey, Michigan, and Oregon northward, Bhutan, also in temperate Northern Hemisphere. In Africa, it is confined to the Atlas Mountains; In China, it is found in South Tibet and also found in many parts of India and Nepal
Pakistan	:	Chitral, Dir, Swat, Hazara, Murree Hills, Rawalpindi, Malir, Amir Laki, Poonch, Kashmir (1525–3660) m. It grows wild in Azad Kashmir and the Swat valley

4.16.2 Ecology

Deciduous shrub found in forests, scrublands, shrubberies, at height of 2500–3600 in Himalayas. As an easily grown plant, it succeeds in most soils but is ill adapted for poor soils and for dry situations. Soils are well drained or moist but well drained, acidic, alkaline or neutral, clay, loam, sand, or chalk. It prefers a deep rich loamy soil in sun or semi-shade. Best if given shade from the early morning sun in spring. It requires shelter from north and east winds. A very ornamental plan, the deliciously scented flowers are produced in the winter and the flowers are said to withstand temperatures down to −12°C without damage. However, fruit is not often produced in this country.

4.16.3 Morphological Description

Deciduous shrub approximately 5 m height, Bark brownish gray. Opposite leaves without stipules, 7.5–6.9 cm long and 3.2–2.9 cm wide, elliptical to oblong, toothed margins, base cuneate, lateral veins prominent, veins straight, slightly curved and branched at margins, petiole bluish black in color, corymbose raceme, flowers paniculate, appearing before leaves onset, fragrant, pink to white in color, calyx tubular, triangular lobes, hairy, obtuse at the apex, corolla pinkish in color, campanulate, spreading, ovate, rounded apex, stamens in two whorls, two attached on the middle of corolla lobes, three inserted on the lower surface, anthers reddish purple elliptical in shape. The fruit from grandiflorum is a small black drupe, which is sweet tasting and has a single stone in it sweet in taste.

4.16.4 Organoleptography

Dried fruits are elongated in shape, dark purplish in color, outer surface rough with irregular vertical lines, length 0.3–1.4 cm, width 0.2–0.7 cm, diameter 0.4–1.5 cm. Fruit sweet in taste, with jam like odor. Internally, the fruit is greenish brown in

color, having irregularly rough texture. Small pores may also be seen on fruit internal surface. Weight of 10 fruits was 2.8 g. The fruit (epicarp, mesocarp and endocarp) is indistinct.

4.16.5 Edible Potential

Parts used: fruit, leaves

4.16.6 Edible and Medicinal Uses

The fruit is edible and whole plant is used to make baskets. The branches from *Viburnum grandiflorum* are used for fencing and fuel, and as yet there have been few clinical trials conducted on it. *Viburnum* has become popular as garden or landscape plants because of their showy flowers and berries, fragrance, and good autumn color of some forms. The fruit is edible and can be eaten either raw or for making jam, while they are mildly toxic and can cause vomiting if eaten in quantity.

The plant is ued as an antispasmodic, astringent, diuretic, uterine sedative in functional uterine disorders. The bark is used in herbal medicine, as an antispasmodic and to treat asthma. Seed juice is given to treat typhoid and whooping cough. Colloidal solution of powdered leaves is taken to relieve abdominal pain. Fruits are used in constipation. Sap of leaves is used in eye infections. It is edible and eaten raw or cooked by locals who also use it for its laxative properties, although it is only a mild laxative. It is also used in traditional medicine as a blood purifier and to regulate a woman's menstrual flow. It could have anticancer benefits as well as have antibacterial properties. It is thought to be a protector of the liver and have anti-inflammatory properties, as well as helpful to the gastric system.

4.16.7 Folk Preparations

(a) Fruits are eaten raw or cooked against constipation. Eight to ten fresh fruits are eaten once daily (preferably in morning) for constipation.
(b) A solution of powdered leaves (8–10 g) is made by boiling them in water, and 1–2 tablespoons of this solution are taken (twice a day) to relive abdominal pain.
(c) Leaves sap is also used in eye infections. Two drops of leaves sap is added to infected eye before sleeping at night.

4.17 *Zanthoxylum armatum* DC

Fig. 4.17 *Zanthoxylum armatum* DC. (**a**) Inflorescence. (**b**) Fruiting branch

4.17.1 Systematic Studies

Botanical name	:	*Zanthoxylum armatum* DC
Family	:	Rutaceae
Common name	:	Winged prickly ash, Hercules' club
Local name	:	Timbar (Urdu)
Conservation status	:	Common in the wild
Habit/habitat	:	A fairly common xerophytic shrub or a small tree, found in the foothills up to 1500 m in Northern Pakistan. Growing in shrubs, woodland, roadsides, forest, hot valleys, and many habitats below 3100 m in the Himalayas

Botanical name	:	*Zanthoxylum armatum* DC
Blooming time	:	March to April
Fruiting period	:	August to October
Distribution		
World	:	Found in the warmer valleys of the Himalaya from Bangladesh to Bhutan, India, Indonesia, Japan, Kashmir, Korea, Myanmar, Nepal, Pakistan, China, Philippines, Thailand, Vietnam, ranging between 1000 and 2100 m above sea level
Pakistan	:	Kurram, Dir, Chitral, Swat, Buner, Gilgit, Balakot Murree, Hazara, Abbottabad, Poonch, Kashmir

4.17.2 Ecology

It prefers a good deep well-drained moisture retentive soil in full sun or semi-shade. Suitable conditions are sandy, loamy and clay soils and prefers well-drained soil. Suitable pH is neutral soils. It can grow in semi-shade (light woodland) or no shade. It prefers moist soil. Flowers are formed on the old wood. Male and female plants must be grown if seed is required.

4.17.3 Morphological Description

Shrub, woody climber or small trees to 5 m tall, spiny, deciduous. Branchlets and leaflet blades abaxially on midvein usually with prickles. Young branchlets and inflorescence rachises glabrous or rust-colored pubescent. Leaves 3–9-foliolate, pellucid-punctate; petiole winged; rachis glabrous, or rust-colored pubescent, wings to 6 mm on each side; leaflet blades subsessile, opposite, lanceolate, ovate, or elliptic, 3–12 cm long, 1–3 cm wide, base attenuate to broadly cuneate, acute; base sometimes oblique; midrib sometimes spiny below, secondary veins 7–15 on each side of midvein and generally faint, margin crenate or entire and often revolute when dry, apex acute to acuminate. Inflorescences terminal on short lateral branchlets and sometimes axillary, 1–7 cm, with less than 30 min flowers. Perianth in two irregular series or one series, with 6–8, undifferentiated 0.3–1.5 mm sepals. Male flowers: stamens 4–6; anthers yellow prior to anthesis; connective apex with oil gland; disc pulvinate; rudimentary carpels lacking. Female flowers: carpels 2 or 3, abaxially often with a conspicuous oil gland; styles recurved; staminodes ligulate or lacking; Ovary 1–3-locular, lobed, pale red, splitting into two when ripe. Fruit follicles are usually purplish red, 4–5 mm in diameter, with a few protruding oil glands. Seeds are shining, round, blackish brown, and 3–4 mm in diameter.

4.17.4 Organoleptography

Unripe fruits are light green and become reddish green on ripening. They have pungent taste, axillary, succulent, fleshy, circular to oval, 0.2–0.6 cm long, 0.2–0.4 cm wide, and 0.6–1.3 cm circumference. Exocarp, mesocarp, and endocarp are indistinct. Dried fruit has wrinkled surface, smells like citrus, and has sour taste. Exocarp is light reddish green, glabrous, rough and spotted surface, pungent. Mesocarp is fused with exocarp. Endocarp is externally black, internally light brown to black, pungent, and hard.

4.17.5 Edible Potential

Parts used: fruit, leaves, seeds, stem

4.17.6 Edible and Medicinal Uses

The seeds and flowers are ground into a powder and used as a condiment in the preparation of certain traditional dishes, i.e., chutneys, curries to improve taste. It is widely used as a pepper substitute. A light roasting brings out more of the flavor. The fruit is rather small but is produced in clusters which make harvesting easy. Each fruit contains a single seed. During winter, a soup made from the dried fruit is consumed by the indigenous people to keep warm. Young leaves are also used as a condiment. The fruit contains essential oil. The fruit is used to purify water. Toothbrushes are made from the branches. Recently people have also started to use powder made from the dried fruit for cleaning teeth. Wood is heavy, hard, close grained, used as fuel by natives. The twigs are used as toothbrushes and the stems are made into walking sticks. Some members of the community consider the tree to have religious significance and magical properties. Walking sticks are made out of its branches. Leaves are used as fodder for goats and sheep. Dried branches are used for fencing and hedges.

Timbar is used in curing various common ailments such as toothache, gas trouble, piles, common cold, cough, and fever—as it is believed to give warmth to the body. The seeds and the barks are used as an aromatic tonic in the treatment of fevers, dyspepsia, and cholera. The fruits, branches, and thorns are considered to be carminative and stomachic. They are used as a remedy for toothache. Common stomach complaints are treated with timbar soup.

4.17.7 Folk Preparations

(a) To cure toothache, a fresh or dry fruit is pressed over the affected tooth and is kept in position till it loses its pungency. This practice is made three times per day to treat toothache.

(b) Dried fruit powder (35–40 g) is mixed with dried leaves powder (18–20 g) of *Mentha longifolia* and table salt (6–8 g). Two teaspoons (7–8 g) of this powdered mixture is given two to three times per day with a glass of water (250 mL) to treat stomach disorders, gas troubles, and indigestion.
(c) Young twigs of 8–10 inches are cut by knife and used as toothbrush (Miswak) daily in the morning for mouth gums and toothache.
(d) Dried seeds (12–14) and bark (7–10 g) are boiled in one and a half cup of water (325 mL). Honey (3–6 g) is added to this decoction and is given (half cup at night) to patient suffering from fever, cough, and cold.

4.18 *Ziziphus sativa* Gaertn

Fig. 4.18 *Ziziphus sativa* Gaertn. (**a**) Inflorescence. (**b**) Fruiting branch

4.18.1 Systematic Studies

Botanical name	:	*Ziziphus sativa* Gaertn
Family	:	Rhamnaceae
Common name	:	Jujube, red date, Chinese date
Local name	:	Ber (Urdu), Beri (Hindko)
Conservation status	:	Common in the wild
Habit/Habitat	:	Found mostly on gravelly or stony slopes of mountains, hills, sunny dry slopes, plains, also widely cultivated; below 1700 m
Blooming time	:	May to June
Fruiting period	:	July to August
Distribution		
World	:	Thought to be in Southern Europe, Mediterranean region, Afghanistan, Lebanon, Iran, Pakistan, India, Bangladesh, Nepal, Mongolia, Japan, southern and central China, Tibet, South and East Asia
Pakistan	:	D. I. Khan, Kohat, Murree, Hazara, Buner, Dir, Chitral, Swat, Gilgit, Balakot, Kashmir, cultivated in Punjab (Margalla Hills, Attock)

4.18.2 Ecology

The tree tolerates a wide range of temperatures and rainfall, though it requires hot summers and sufficient water for acceptable fruiting. Unlike most of the other species in the genus, it tolerates fairly cold winters, surviving temperatures down to about −15 °C (5 °F). This enables the jujube to grow in mountain or desert habitats, provided there is access to underground water through the summer. The species *Ziziphus jujuba* grows in cooler regions of Asia. It succeeds in most soils so long as they are well drained. Prefers an open loam, dry, or moist soil and can tolerate drought. Jujube mostly succeeds well in an alkaline soil. Plants are fast growing, even in poor soils. Plants are hardy to about −20 °C.

4.18.3 Morphological Description

A small tree or shrub, deciduous, reaching a height of 5–10 m (16–33 ft), with spreading branches, glabrous, prickles stout, straight up to 3 cm long, older tree unarmed. Bark brown or gray brown, with long reduced branches, without buds; branchlets (new branches) purple red or gray brown, flexuous, smooth, with two stipular spines or not; long spines erect, to 3 cm, stout; short spines recurved, developed from old branches; annual branchlets pendulous, green, solitary or 2–7-fascicled on short shoots. Stipular spines slender, caducous; petiole 1–6 mm, or to 1 cm on long shoots, glabrous or sparsely puberulent; leaf blade abaxially pale green,

adaxially dark green, ovate, ovate-elliptic, or elliptic-oblong, 3–7 × 1.5–4 cm, obtuse-subacute, papery, finely toothed margin abaxially puberulent on major veins or glabrous, adaxially glabrous, 3-veined from base, base slightly asymmetric, slightly cordate, subrounded, margin crenate-serrate, apex obtuse or rounded, rarely acute, mucronulate; petiole very short, 1–2 mm long. Inflorescence of axillary clusters. Flowers yellow-green, bisexual, 5-merous, glabrous, solitary or 2–8 crowded in axillary cymes, shortly pedunculate. Pedicel 2–3 mm long. Sepals ovate-triangular, acuminate, adaxially distinctly keeled. Petals obovate, as long as stamens, clawed at base, 2 mm long, yellowish green in color. Disc orbicular, thick, fleshy, five lobed. Ovary basally slightly immersed in disc; style two cleft to half. Drupe red at maturity, turning red purple, globose, oblong or narrowly ovoid, succulent, shining, 2–3.5 cm long and 1.5–2 cm in diameter, eventually wrinkled, looking like a small date; mesocarp fleshy, thick, sweet or sour taste; stone acute or obtuse at both ends, two-loculed, one- or two-seeded; fruiting pedicel 2–5 mm or longer. Seeds 1 × 0.8 cm in size, compressed-orbicular.

4.18.4 Organoleptography

The drupe is reddish maroon to orange black when fully riped. It is small, fleshy, glaucous in texture, rounded oval in shape and short stalked. Fresh fruit is sweet in taste, about 1.5 cm long, 0.7 cm wide, and 2.8 cm in circumference. The fruit (epicarp, mesocarp, and endocarp) is distinct. Dried fruit has rough surface but shiny having sweet fruity fragrance and taste. Internally fruit is cream white to yellow in color and pulp is granular. Seed enclosed inside a pulp is hard with longitudinal grooves. Seed is camel brown in color, bitter, but odorless.

4.18.5 Edible Potential

Parts used: fruit, bark, leaves

4.18.6 Edible and Medicinal Uses

It is an economically important tree or shrub. Fruit is edible in raw form, as it is mealy having a sour to sweet flavor. The fruit can be eaten fresh, dried like dates or cooked in puddings, cakes, breads, jellies, soups, etc. The dried fruit has the nicest taste. The fruits are often left to become wrinkled and spongy, which increases their sweetness, and are then eaten fresh or cooked. The fruit can be used also as a coffee substitute. There is a local myth about jujube's sweet smell that it is believed to make teenagers fall in love, as a result, in the Himalaya and

Karakoram regions, boys take a stem of sweet-smelling jujube flowers with them or put it on their hats to attract girls. Plant can be grown as a hedge. The leaves are hanged in homes to keep smelling fresh and clean. It is also used to keep bugs and other insects out of the house and free of infestation. The bark contains tannin used for tanning of animal hides. Wood is dense, hard, compact, and tough, thus used for turnery, agricultural implements, etc. The wood is also used to make bowls, beads, and violin parts. It makes an excellent fuel and a good charcoal. Young branches are browsed by goats.

Jujube is an effective herbal remedy having antidote, emollient, expectorant, antifungal, antibacterial, antiulcer, anti-inflammatory, diuretic, and wound healing properties. The plant is a folk remedy for anemia, hypertonia, nephritis, and nervous diseases. It aids weight gain, improves muscular strength and increases stamina. It is prescribed as a tonic to strengthen liver function. Jujube increases immune system resistance. The dried fruits are anticancer, refrigerant, sedative, stomachic, styptic, and tonic. They are considered to purify the blood and aid digestion. They are used internally in the treatment of a range of conditions including chronic fatigue, loss of appetite, diarrhea, pharyngitis, bronchitis, anemia, irritability, and hysteria. The seed is narcotic, sedative, stomachic, and tonic. It is used internally in the treatment of insomnia, nervous exhaustion, night sweats, and excessive perspiration. The root is used in the treatment of dyspepsia, ulcers, and fever. The leaves are astringent and febrifuge. They are said to promote the growth of hairs. The plant is widely used externally as a treatment for burns.

4.18.7 Folk Preparations

(a) The dried powders of jujube fruits, *Viola odorata* flowers and *Glycyrrhiza glabra* root mixed in equal quantity (10 g each) and boiled in one and a half glass of water (375 mL) for 15–20 min. This decoction is strained, and one cup is taken daily at night to cure asthma, cold, cough, fever, and flu.
(b) A paste is made from root and leaves powder (25 g each in 50 mL of water) and applied externally (twice a day) to old wounds, boils, burns, and ulcers.
(c) Fresh leaves and fruits (6–8 each) are boiled in a cup of water (250 mL) and filtered. This decoction is used as gargle at night to cure sore throat and bleeding gums.
(d) A pinch (2–3 g) of dried bark powder is taken with boiled water (two times per day) in diarrhea and dysentery.
(e) Juice is extracted from root (10–15 mL/60–70 g) and applied externally (at night) to rheumatic joints and gout.
(f) Two teaspoons (10–12 g) of dried fruit powder is taken (two times per day) with a glass of milk for relieving chronic constipation.

Chapter 5
Nutritional Contents and Analysis of Edible Wild Plants

Edible wild plants are economical, important, and good sources for vitamins, fibers, minerals, and antioxidants. These plants have curing ability for multiple disorders like cardiovascular problems, diabetes, digestive and urinary tract disorders, inflammation, etc. The conventionally utilized edible wild plants also possessed antibacterial and anticancer activity which adds value to their nutraceutical worth. In developing countries dependence on wild nutraceutical plant is quite customary. Numerous studies have explored the nutritional and medicinal worth of edible wild plants and reported the health potential ingredients (minerals, organic acids, and dietary fibers) among these plants [19, 20]. The results of their studies supported the fact that these wild fruits and vegetables are potentially viable sources for maintenance of health. Microelements in edible wild plants are significant in curing and preventing of multiple diseases. A small proportion of available plant minerals plays an important role in the maintenance of human body metabolism [26]. It has been found that Asian edible wild plants are worthwhile sources of natural antioxidants because they contain high amounts of phenolic compounds [25, 26]. The *Sageretia theezans* fruit studies revealed its nutritional and nutraceutical value. Its fruit is not only found to be rich in potassium, malic acid, and oleic acid but also showed antioxidant and antidiabetic competencies due to significant flavonoid and phenolic content [23].

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5.1 General Benefits of Wild Edible Plants

- **Fresh and free**
  Multiple studies have shown that vegetables and fruits lose their vitamin and mineral contents after longer storage times. So if you are taking the wild edible plants from your native habitat, you can enjoy them as fresh and healthy. It will be fresher than the vegetables and fruits available in your supermarket because in stores, most of the food comes from far way and is not as fresh as you can get from the wild.

- **Stronger in genetics**
  As we know that wild edible plants grow in the wild conditions where they have to compete for resources, they fight against other weeds, insects, or herbs for their survival. Hence, through all this practice, their genes become stronger and competitive than other cultivated species. On the other hand, the cultivated species are hybridized with the aim to increase their beauty and stability. The qualities like nutritional value, flavor, and others do not gain much weightage of consideration. We have prepared seedless grapes and watermelon through scientific approach but the question is, without seed how would they propagate in wild? Similarly the genetic engineering in agriculture also focuses only for plant stability by making it resistant to weed, herb, fungi, or other pests. The nutrition of improved plants is not the main goal. Hence, the wild edible plants are more nutritious with unaltered genetic makeup.

- **Free from commercial fertilizers**
  Wild plants like to grow in that habitat which favors their growth, and they flourish there without the use of artificial fertilizers. They enjoy the fertilizers by nature which could be in the form of animal waste, casting of earthworm, and leaf litters. All of these decaying organic matters sufficiently provide the required nutrients for their growth. However, the cultivated plants cannot withstand in nature without application of synthetic fertilizers which are usually prepared by petrochemical sources. These commercial fertilizers are good for plant vigor but can have long lasting effect on human health.

- **Free from pesticides, fungicides, and herbicides**
  It is well known that commercially available plants grow under the use of pesticide, fungicides, and herbicides. Without them cultivated plant cannot protect itself, and these chemicals are potentially hazardous for human health; however wild plants are free from such kind of chemical treatment. Wild edible plants are the great resource for those people who want to eat chemical free food. But wild plants could also be contaminated if they are found near to cultivated lands. In that case they cannot avoid the effect of pesticides. So collection of wild flora should be done with great care.

- **Free from wax coating**
  Many of the products available in store are used to coat with food-graded wax to avoid spoilage of particular food. This wax is not free from pesticides as well, and it is prepared by the lac resin which is the excreta of *Laccifer lacca* (an insect). Wild plants do not need to be coated by any of such hazardous and unpleasant thing.
- **Drought resistant**
  One of the key features about wild edible plants is that they have deep root system which enable them to suck the water from depth and can survive in droughts as well.
- **Increase in your immunity**
  Your native wild plants are facing the same environment as you are facing; this means they also fight against some common pathogens and immunity against them. So by eating those wild edible plants, your immunity can also be magnified.
- **Getting extra vitamin D**
  Those people who collect wild edible plants as hobby or by profession are more exposed to sun and can get more vitamin D.

5.2 Role of Edible Wild Plants in Balanced Diet

The restriction of people diet to conventional food items not only creating hunger problem but also causing vitamin and mineral deficiencies. This malnutrition and nutrient deficiencies can be overwhelmed by incorporating edible wild plants into our food. So these plants could help in improving the diet of poor and undernourished people as well [2]). Edible wild plants have significantly higher nutritional content, suggesting them as important contributors in balanced diet. Numerous national and international nutritional researchers [13, 15] evaluated the nutritional value of edible wild plants and recommended them as alternate food resources. These plants provide a range of affordable energy resources, because they are not only cheap and accessible but also rich in fats, proteins, and carbohydrates [16]. These are complementing conventional staple food in relation to providing balanced diet. These plants are not only rich in macromolecules but also contain high values of energy, mineral, vitamin, and fiber content [17, 18, 19 20]. For instance, in a single 100 g of cooked dandelion, there will be around 11,000 mg of K (potassium), 42 mg of Ca (calcium), and 18 mg of vitamin C. They are considered to contain higher amounts of nutritional and bioactive compounds than cultivated species.

5.3 Nutritional Explorations of Edible Wild Plants

Malnutrition is a chief health burden in developing countries, and to identify if nutritional security and biodiversity are related is fundamental for recruiting policy support to secure wild food use and preserve habitats for wild edible species. Comprehensive food composition data is a critical first step.

This is particularly important for societies most vulnerable to malnutrition. However, understanding of wild foods' micro- and macro-nutritional properties presently lags behind that of cultivated species.

The contribution of dietary energy from traditional food species in 12 indigenous communities has been found to range from 30 to 93% of total dietary energy.

Internationally multiple scientists work on the exploration of nutritional wealth of these edible wild plants. In 2010 a study was conducted on food security challenges in Ethiopia, and it concluded that indigenous edible wild plants should be incorporated in routine diet to eradicate the food security issues in Ethiopia [19]. Sena et al. [19] analyzed the nutrient content of *Ceratotheca sesamoides*, *Ziziphus mauritiana*, *Moringa oleifera*, *Leptadenia hastata*, *Amaranthus viridis*, *Adansonia digitata*, and *Hibiscus sabdariffa*. All of these plants are used by Nigerian people during hard times of famine, and they found them as highly nutritious. Nutritional studies of edible wild plants related to multiethnic regions of Northeast India revealed 16 plant species with high proximate values. Researchers concluded that edible wild plants work as key factor in the maintenance of nutritional balance, and with proper strategic planning, they can be incorporated in food system to achieve sustainability.

An ethnobotanical survey was conducted in Ayubia National Park, Pakistan, by Ahmad and Javed in 2007. This survey revealed six significant underutilized species, i.e., *Adhatoda vasica*, *Artemisia scoparia*, *Galium aparine*, *Amaranthus viridis*, *Hedera nepalensis*, and *Urtica dioica*, for medicinal and edible uses.

In 2013 a survey was made on KPK (Khyber Pakhtunkhwa) wild dietary plants, and it revealed that 17 plants from 14 families have been utilized as food in rural communities. This ethnobotanical data was analyzed on scientific grounds by exploring the nutritional value of these indigenous wild edible plants. Results supported the fact that studied species confined significant quantities of protein, basic fat, and crude fiber. This study concluded that all of these plants were found to be rich in key nutrients and poor in anti-nutritional content which supports their utilization as human food.

5.4 Examples of Nutritional/Medicinal Content of Some Wild Edibles

5.4.1 Taro

Taro is very common in the wild. The root or corm is the customary part that you eat, but the stems and leaves are also edible. The stems and leaves should be cooked to dissolve the raphides (sharp calcium oxalate crystals). Once dissolved, they are a form of usable calcium.

The root is a very good source of carbohydrates. Hundred grams of root contains about 26 g of carbohydrate. This is about 20% of your daily necessity, so a twosome of roots possibly equals to about half of your daily carbohydrate requirement, which is certainly enough to keep your energy level up and your brain functioning properly.

Taro is a good source of B complex vitamins. Minerals like zinc, magnesium, copper, iron, manganese, and potassium are present in it.

5.4.2 Colocasia

Another plant quite common in the family Araceae is *Colocasia*. This is rich in essential amino acids. As our body stores nonessential amino acids, eating wild plants would provide us with a complete protein. This tropical fruit contains calcium, phosphorous, iron, and vitamin C.

5.4.3 Torch Ginger

Torch ginger flower (genus *Etlingera*) contains nearly 4.5 g of carbohydrate per 100 g.

5.4.4 Ivy Gourd: Pak Tamlueng

This climber is *Coccinia grandis*. The leaves, young shoots, and berries are all edible. Medicinally, this is a miracle plant! It has the following characteristics:

- Anti-inflammatory—used to heal wound
- Anticonvulsive—used to treat respiratory inflammation
- Antiulcer
- A cough suppressant
- An astringent poultice

- Used to treat diabetes, gout, and skin diseases
- Antipyretic

5.4.5 Wood Sorrel

Wood sorrel (family Oxalidaceae) leaves, flowers, seeds, sprouts, and roots are all edible. It is very similar in look and taste to clover.

Wood sorrel is packed with vitamins and minerals, including calcium, chromium, magnesium, niacin, phosphorus, potassium, thiamine, vitamin C, lecithin, vitamin A, vitamin E, vitamin B2 (riboflavin), vitamin B3 (niacin), iron, zinc, and selenium.

Approximately 70% of the caloric value of wood sorrel is in the form of amino acids. Wood sorrel is not a complete protein, but if eaten with something that supplies the missing amino acids, it would make a respectable protein supplement.

When in the sprout form, which is always the most nutritious stage in a plant's life, 100 g of wood sorrel provides 4 g of protein.

Wood sorrel flowers are, of course, high in carbohydrates (sugar), and as sugar is converted to glucose, which is the brain's fuel, you would definitely be doing yourself a favor by eating as many clover flowers as possible.

So, in a survival situation, you should grab all of the wood sorrel you can find, pull up the roots too if possible, and eat it all.

Chapter 6
List of Useful Edible Wild Plants for Daily Use

6.1 Wild edible plants study in Bullen District Northwest Ethiopia

S. Shaheen et al., *Edible Wild Plants: An alternative approach to food security*,
DOI 10.1007/978-3-319-63037-3_6

List of the reported wild edible plants in study area based on family name, scientific name, local name, habit, part used, and mode of consumption and preparation

Family	Scientific names	Local name	Habit	Part used	Preparation and mode of consumption	Habitat
Acanthaceae	*Acanthus sennii* Chiove	Koshosha (SH)	H	Flower nectar	Juice of flower nectars is sipped by lip	WL, FL
	Justicia ladanoides Lam.	Kakim (GU)	H	Leaves	Flesh leaves are boiled and eaten	RV EL
	Justicia schimperiana Hochst. ex Nees	Dumuga (SH)	S	Flower nectar	Juice of nectars is sipped by lip	FE
Amaranthaceae	*Amaranthus caudatus* L.	Darka (GU)	H	Leaves and young shoot	Young leaves and shoots of plants are eaten after being cooked with *Phaseolus vulgaris* L.	HG, RS
	Amaranthus cruentus Thell	Lama (SH)	H	Leaves and seed	Leaves are eaten cooked and the seed is grinded and eaten when it is changed to porridge	HG, WL
	Amaranthus hybridus L.	Dahka (GU)	H	Leaves	Leaves are eaten boiled	HG, RS
Anacardiaceae	*Rhus retinorrhoea* Oliv.	Kefijanga (SH)	T	Fruit	Fruit is eaten raw	WL
	Rhus vulgaris Meikle	Bakitela (SH)	S	Fruit	Fruit is eaten raw	RV, WL
	Rhus ruspolii Engle.	Qamo (SH)	T	Fruit	Fruit is soaked with straw until it is ripe and eaten raw	WL
Annonaceae	*Annona cherimola* Mill	Gishita (SH)	T	Fruit	Fruit is eaten raw	WL, FE
	Annona senegalensis Pers.	Bambuta (SH)	T	Fruit	Fruit is eaten raw	WL
Apocynaceae	*Carissa spinarum* (Forssk) Vahil.	Soha (GU)	S	Fruit	Fruit is eaten raw and as juice	WL, RV
	Saba comorensis (Boji.) Pichen	Fuya (SH)	C	Fruit	Fruit is eaten raw	RV

Apiaceae	*Anethum graveolens* (Mill)	Lubicha (GU)	H	Leaves	Leaves are eaten raw or after being cooked with *Cucurbita pepo*	RS, RV
	Foeniculum vulgare (Mill)	Qushuwa (SH)	H	Leaves	Leaves are squeezed with *Allium sativum* L. and used as condiment	HG
Asteraceae	*Vernonia amygdalina* Del	Banjaga (GU)	H	Leaves	Leaves are eaten either raw or cooked	WL DR
	Bidens pilosa L.	Tsetsega (SH)	H	Leaves	Leaves are eaten after being boiled	RS
Araceae	*Colocasia esculenta* (Hochst)	Kompha (SH)	H	Tubers	The tuber is cut off, dried for 1 day, and eaten after being properly boiled	RV, HG
Arecaceae	*Borassus aethiopum* Mart.	Goha (SH)	T	Fruit and young seedling	Germinating parts are eaten after being boiled, and the fruit is eaten raw after soaking with straw for a month	WL
	Phoenix reclinata Jacq	Wola (SH)	S	Fruit and stem	External surface of the young stem is removed by sharp materials and boiled for 2 days until toxic substances are removed and then after staying for 30 min before eating. Fruit is eaten raw or after soaking with straw until it is ripened	FM, WL
Balanitaceae	*Balanites aegyptiaca* (L.) Del.	Qota (SH)	T	Fruit	Fleshy exocarp of the fruit is removed first and then the stony mesocarp is broken, and the endocarp fruit is roasted and is eaten after getting immersed with alcohol for sexual excitement and to neutralize the alcoholic effects	WL
Boraginaceae	*Cordia africana* Lam.	Banja (SH)	T	Fruit	The fruit is eaten raw	WL, FM

(continued)

Family	Scientific names	Local name	Habit	Part used	Preparation and mode of consumption	Habitat
Celastraceae	*Maytenus senegalensis* (Lam.) Excell.	Tisha (GU)	S	Fruit	The fruit is eaten raw	WL
	Salacia congolensis (Wild.)	Tsera (SH)	S	Stem bark	The internal part of stem bark is removed carefully ground and the extracted juice is used as sauce	WL
Commelinaceae	*Commelina africana* L.	Echaya (GU)	T	Leaves	Leaves are eaten after cooking	WL
Cucurbitaceae	*Cucurbita pepo* L.	Maximara (SH)	C	Leaves	Young leaves are eaten after cooking	HG
	Gladiolus candies (Rendle)	Engula (SH)	C	Young shoot	Young shoots are eaten after cooking	RV
	Momordica foetida Schumach.	Badha (SH)	C	Leaves and fruit	Young leaves are eaten after cooking and the fruit endocarp is eaten raw	RV
Dioscoreaceae	*Dioscorea cayenensis* Lam.	Egera (GU)	C	Tubers/root	The poisonous parts of tubers are removed and the remaining parts are eaten after cooking	WL, RV
	Dioscorea prehensilis Benth	Anga (GU)	C	Root/tubers	Boiled tuber is eaten	WL
Ebenaceae	*Diospyros mespiliformis* Hoechst	Maranta (SH)	T	Fruit	Fruit is eaten raw	RV, FL
Erythroxylaceae	*Erythroxylon fischeri* Engle	Tiriga (GU)	H	Leaves	The leaves are eaten raw	HG
Euphorbiaceae	*Bridelia micrantha* Hoechst	Yejega (GU)	T	Fruit	The fruit is eaten raw	WL, FL
	Croton macrostachyus Del.	Shekeshek (SH)	T	Leaves	Young cooked shoots eaten	WL
	Bridelia scleroneura Muell.Arg.	Ajega (GU)	T	Fruit	The fruit is eaten raw	WL, FL
	Sapium ellipticum L.	Andirgago (SH)	S	Fruit	The fruit is eaten raw	RC
	Clutia lanceolata Hoechst	Doguha (SH)	S	Fruit	The fruit is eaten raw	WL

Fabaceae	*Senna obtusifolia* (L.) Irwin & Barneby	Bamdisa (GU)	H	Seed	Endocarp is eaten raw	HG, RS
	Piliostigma thonningii (Schum.) Milne-Redh	Mac'a (SH)	T	Fruit	Fruit is eaten raw	WL
	Tamarindus indica L.	Dogha (SH)	T	Fruit	Fleshy exocarp is eaten raw	WL
Flacourtiaceae	*Oncoba spinosa* Forssk.	Ula (SH)	S	Fruit	Fleshy endocarp is eaten raw	WL
Loganiaceae	*Strychnos innocua* Del.	Oola (SH)	T	Fruit	The fruit is eaten raw	WL, DR
	Strychnos spinosa L.	Merenza (GU)	T	Fruit	The fruit is eaten raw	WL
Malvaceae	*Abelmoschus esculentus* (L.)	Andeha (GU)	H	Fruit	The fruit is eaten raw	HG
	Abelmoschus ficulneus (L.) Wight	Andha yiza (SH)	H	Fruit	The fruit is eaten raw	HG, FM
	Hibiscus cannabinus L.	Tisha (GU)	H	Leaves	Leaves are burned until they form ash and are used as salt	HG, FL
Moraceae	*Ficus vasta* Forssk	Bowa (GU)	T	Fruit	The fruit is eaten raw	RV, F
	Ficus sur Forssk	Essa (SH)	T	Fruit	The fruit is eaten raw	RV
	Ficus sycomorus L.	Fuqa (GU)	T	Fruit	The fruit is eaten raw	WL, FL
	Morus alba L.	Injor (SH)	S	Fruit	The fruit is eaten raw	FE
Moringaceae	*Moringa stenopetala* Lam	Sheferwu (SH)	S	Y, L	Cooked young leaves, eaten with *Phaseolus vulgaris* L. and rice	HG
Musaceae	*Ensete Ventricosum* (Wild)	Echecha (SH)	T	Fruit	The fruit is eaten raw	RV, HG
	Eugenia uniflora L.	Badirbonga (SH)	S	Fruit	The fruit is eaten raw	WL

(continued)

Family	Scientific names	Local name	Habit	Part used	Preparation and mode of consumption	Habitat
Myrtaceae	*Syzygium guineense* (Wild.) Dc. sp. guineense	Daguwa (GU)	T	Fruit	The fruit is eaten raw or drunk in juice form	RV
	Syzygium guineense (Wild.) Dc. ssp. macrocarpum	Diwa (SH)	T	Fruit	The fruit is eaten raw	WL, FL
Poaceae	*Oxytenanthera abyssinica* (A. Rich.) Munro	Soha (GU)	H	Seeding	The young seedling boiled and eaten with bread	WL, HG
Polygonaceae	*Rumex abyssinicus* Jacq	Ambata (SH)	H	Root	Root grinded by mortar and the squeezed part used as food decoction	HG
Olacaceae	*Ximenia americana* L.	Meyo (GU)	T	Fruit	The fruit is eaten raw	WL, FL
Portulacaceae	*Portulaca quadrifida* L.	Kiwa (SH)	H	Leaves	The shoot part is ground together with *Allium sativum*, *Foeniculum vulgare*, and *Ruta chalepensis* to form sauce and eaten with porridge and injeria (local bread)	HG, FL
Sapotaceae	*Mimusops kummel* A.DC.	Shemiya (SH)	T	Fruit	The fruit is eaten as raw	WL, FL
Solanaceae	*Lycopersicon esculentum* Mill	Komidira (SH)	H	Fruit	The fruit is eaten raw	R
	Physalis peruviana L.	Bosiya (SH)	H	Fruit	The fruit is eaten raw	RS, DA
	Solanum nigrum L.	Func'a (SH)	H	Fruit and leaves	The fruit is eaten raw and the leaves are eaten raw together with green pepper	HG, RS
Rhamnaceae	*Ziziphus abyssinica* Hoechst	Anguga (GU)	T	Fruit	The fruit is eaten raw	WL
	Ziziphus spina-christi (L.) Wild	Sirah (GU)	T	Fruit	The fruit is eaten raw	WL

Sapindaceae	*Lepisanthes senegalensis* Pers	Bekuda (SH)	S	Fruit	The fruit is eaten raw	WL
Rubiaceae	*Gardenia ternifolia* Schumach & Thonn.	Gaaba (GU)	T	Fruit	The fruit is eaten raw	WL, FL
	Pavetta crassipes (K. Schum)	Munqa (SH)	S	Fruit	The fruit is eaten raw	WL, FL
	Vangueria apiculata L.	Hawa (SH)	S	Fruit	The fruit is eaten raw	FM
Tiliaceae	*Grewia bicolor* Juss	Somoya (SH)	S	Fruit	The fruit is eaten raw	FE, FL
	Grewia ferruginea Hochst. ex A.Rich	Galqoriya (SH)	S	Fruit	The fruit is eaten raw	WL
	Grewia mollis Juss	Qoriya (GU)	S	Stem bark	The inner parts of stem bark are safely removed and soaked with hot water and grinded and collecting juice used as sauce	WL, FL
	Grewia schweinfurthii Burret	Badiriya (GU)	S	Leaves	The fruit eaten raw	RV, FL
	Corchorus olitorius L.	Laliaq (SH)	H	Leaves	Young leaves eaten raw or after being cooked	FL, DR
Verbenaceae	*Vitex doniana* Sweet	Kokor (SH)	T	Fruit	The fruit is eaten	WL
Ulmaceae	*Celtis africana* Brum.f.	Qawo (GU)	T	Fruit	The fruit is eaten raw	DR
Zingiberaceae	*Etlingera littoralis* L.	Zingibila (GU)	H	Tuber	The fruit is eaten raw	RV

Growth habit: *T* tree, *H* herb, *S* shrub, *C* climber; local name: *GU* Gumuzegna, *SH* Shinashegna; habitat: *WL* woodland, *FL* farmland, *HG* home garden, *DR* dry river bed, *RV* riverine forest, *RS* roadside, *FM* forest margin, *FE* fences, *RC* rocky or dry forest

6.2 Wild edible plants diversity in Nepal (Uprety et al. 2012)

Latin name, botanical family, and growth habit	Vernacular name(s)‡	Local use(s) (edible only)	Collection period	Additional local use(s)
Acacia rugata (Lam.) Voigt Leguminosae, climber	Shikakai (Np.); Aila (Mag.); Lashiur (Thr.)	Young shoots used to make pickle or cooked as vegetable	June–August	Fruits used as detergent
Aegle marmelos (L.) Corrêa Rutaceae, tree	Bel (Np.); Ber (Thr.)	Pulp of ripe fruits eaten fresh and also taken as syrup	March–June	Plant of ritual importance. Fruit juice used as fish poisoning. Unripe fruits taken to treat diarrhea
Antidesma acidum Retz. Euphorbiaceae, tree	Dakhi (Thr.)	Fruits edible. Young leaves used to make pickle	September–May	Leaves used as fodder
Ardisia macrocarpa Wall. Myrsinaceae, tree	Paniphal (Np.); Damarai (Thr.)	Ripe fruits edible	August–September	–
Arisaema tortuosum (Wall) Schott Araceae, Herb	Baanko (Np.)	Aerial parts used as vegetable	April–July	–
Artocarpus lakoocha Roxb. Moraceae, Tree	Badahar (Np.)	Ripe fruits eaten fresh. Young shoots cooked as vegetable	June–August	Leaf juice used to make fermenting material locally called “Marcha.” Leaves used as fodder
Asparagus racemosus Willd Liliaceae, herb	Kurilo, Jhirjhire kanda (Np.); Kurla (Thr.)	Tender shoots eaten as vegetable or used to make pickle	June–July	–
Bambusa arundinacea Willd Poaceae, herb	Bans (Np.)	Young shoots eaten as vegetable	June–August	Leaf juice used to treat jaundice. Root juice used in otitis “Kan pakne”
Bambusa nepalensis Stapleton Poaceae, herb	Choya bans (Np.)	Young shoots eaten as vegetable	June–August	–

Bauhinia purpurea L. Leguminosae, tree	Tanki (Np., Bk.)	Flowers and young shoots eaten as vegetable	March–May	Leaves used as fodder
Bauhinia vahlii Wight & Arn. Leguminosae, climber	Bhorla (Np.); Malu, Namarain, Moharain (Thr.)	Pods eaten as vegetable. Fruits edible	August–February	Stem bark used to make ropes. Leaves used to make umbrella "Ghoom" and traditional plates "Duna" and "Tapari" for ritual functions. Bark juice used as fermenting material and to cure blood dysentery
Bauhinia variegata L. Leguminosae, Tree	Koiralo (Np.); Koilar (Thr.)	Young shoots and leaves eaten as vegetable. Flowers eaten as vegetable or used to make pickle	March–May	–
Benincasa hispida (Thunb.) Cogn. Cucurbitaceae, Climber	Kubhindo (Np., Bk.)	Fruits used to make pickle or vegetable	August–November	–
Bombax ceiba L. Bombacaceae, tree	Simal (Np.); Samura, Semara (Thr.)	Young flowers eaten as vegetable	December–March	Seeds used to make yeast and to treat abdomen pain. Young flowers used as fodder
Buchanania latifolia Roxb. M.R. Almeida Anacardiaceae, tree	Piyar, Piyari (Thr.)	Young shoots eaten raw. Fruits edible	May–June	Leaves used as fodder
Caesalpinia decapetala (Roth) Alston Leguminosae, shrub	Karauji, Kanja (Thr.)	Fruits edible	April–September	–
Capparis spinosa L. Capparaceae, shrub	Baganchuwa (Thr)	Young shoots used to make pickle or vegetable	October–November	–
Carissa carandas L. Apocynaceae, Shrub	Chutro (Np.); Karaudi (Thr.)	Fruits edible	June–July	Root juice used in abortion

(continue)

Table 6.2 (continued)

Latin name, botanical family, and growth habit	Vernacular name(s)‡	Local use(s) (edible only)	Collection period	Additional local use(s)
Castanopsis indica (Roxb. ex Lindl.) A.DC.	Katus (Np.); Katwas, Jheru (Mag.)	Fruits edible. Young shoots eaten as vegetable	September–November	Leaves used as fodder
Fagaceae, tree				
Cinnamomum tamala (Buch.-Ham.) T. Nees & Eberm.	Tejpat (Np.)	Leaves and bark used as spices	October–December	Leaves used as fodder
Lauraceae, tree				
Cissus javana DC.	Jogi lahara (Np.)	Leaves used to make pickle	September–November	–
Vitaceae, climber				
Cleome viscosa L.	Ban tori (Np.)	Seeds used as spice	September–November	–
Cleomaceae, herb				
Coccinia grandis (L.) Voigt	Gol kakri, Ban kakri (Np.)	Fruits edible	July–December	–
Cucurbitaceae, climber				
Colocasia esculenta (L.) Schott	Karkalo (Np., Bk.), Gabda (Thr.)	Tuber and leaves eaten as vegetable	Whole year	–
Araceae, herb				
Crateva unilocularis Buch.-Ham	Sipligan (Np.)	Young shoots eaten as vegetable	January–March	–
Capparaceae, tree				
Dendrocalamus hamiltonii Nees & Arn. ex Munro	Tamabans (Np.)	Tender shoots eaten as vegetables	September–October	Shoots used to make flute "Basuri"
Poaceae, herb				
Dillenia pentagyna Roxb.	Agaie (Thr.)	Young shoots and flowers eaten as vegetable	March–April	–
Dilleniaceae, tree				
Dioscorea bulbifera L.	Githa (Np.)	Fruits eaten as vegetable	November–December	–
Dioscoreaceae, climber				
Dioscorea deltoidea Wall. ex Griseb.	Bhyakur (Np.)	Tuberous roots eaten as vegetable	November–February	–
Dioscoreaceae, climber				

Diospyros malabarica (Desr.) Kostel	Tendu, Tendak (Thr.)	Fruits edible	April–May	Leaves used to make cigarettes "bidi"
Ebenaceae, tree				
Diplazium esculentum (Retz.) Sw.	Neuro (Np.); Kochiya (Thr.)	Young shoots eaten as vegetable	April–June	–
Woodsiaceae, herb				
Diploknema butyracea (Roxb.) H.J. Lam	Chiuri (Np.)	Ripe fruits edible	April–July	–
Sapotaceae, Tree				
Ensete glaucum (Roxb.) Cheesman	Ban kera (Np.)	Fruits edible	September–December	–
Musaceae, herb				
Ficus auriculata Lour.	Nebaro (Np.)	Ripe figs edible	June–July	Leaves and twigs used as fodder
Moraceae, tree				
Ficus benghalensis L.	Bar (Np.); Bargad (Thr.)	Ripe figs edible	April–June	Milky latex used in scabies. Plant used as fodder, fuelwood, and in religious functions
Moraceae, tree				
Ficus hispida L.f. Moraceae, tree	Thote, Khasreto (Np.)	Fruits edible or used to make pickle	June–September	Leaves and twigs used as fodder
Ficus lacor Buch.-Ham.	Kabro (Np.); Pakadi (Thr.)	Young shoots eaten as vegetable	March–May	–
Moraceae, Tree				
Ficus racemosa L.	Dumri (Np.); Daurai, Gullar (Thr.)	Ripe figs edible	July–September	Leaves and twigs used as fodder
Moraceae, Tree				
Ficus sarmentosa Buch.-Ham. ex Sm.	Bedulo (Np.)	Ripe figs edible	July–September	–
Moraceae, tree				
Ficus semicordata Buch.-Ham. ex Sm.	Khanneu, Khaniyo (Np.)	Ripe figs edible	June–July	Leaves and twigs used as fodder
Moraceae, tree				

(continued)

Table 6.2 (continued)

Latin name, botanical family, and growth habit	Vernacular name(s)‡	Local use(s) (edible only)	Collection period	Additional local use(s)
Grewia optiva J.R. Drumm. ex Burret Tiliaceae, tree	Phorsa, Phorshat (Thr.)	Fruits edible	September–December	–
Hydnum repandum L. Hydnaceae, fungi	Chyau (Np., Bk.)	Whole plant eaten as vegetable or used to make pickle	March–July	–
Lannea coromandelica (Houtt.) Merr. Anacardiaceae, Tree	Dabdabe (Np.); Jangra (Thr.)	Fruits edible	July–October	Leaf juice used in cuts
Madhuca longifolia (J. König ex L.) J.F. Macbr. Sapotaceae, tree	Mahua (Thr.)	Succulent flowers eaten fresh. Fruits edible	March–July	Seed cake used as fish poisoning. Flower used to make local liquor. Leaves used as plates
Mangifera indica L. Anacardiaceae, tree	Aamp (Np.); Sathak (Mag.)	Fruits eaten raw or used to make pickle	June–July	Bark juice used in pneumonia and stomach disorders
Manihot esculenta Crantz Euphorbiaceae, shrub	Simal tarul (Np., Bk.)	Tuberous roots eaten as vegetable	December–February	–
Melastoma malabathricum L. Melastomataceae, Shrub	Angeri (Np.)	Ripe fruits eaten fresh	July–December	–
Momordica dioica Roxb. ex Willd. Cucurbitaceae, climber	Ban karela (Np.)	Fruits eaten as vegetable	August–November	–
Moringa oleifera Lam. Moringaceae, tree	Sital chini, Saijan (Np.)	Pods used as vegetable	April–June	–
Morus nigra L. Moraceae, tree	Kimbu (Np.)	Fruits edible	May–July	–
Murraya koenigii (L.) Spreng. Rutaceae, shrub	Kari Patta, Boke (Np.); Binbinveria (Thr.)	Leaves used as spices. Ripe fruits eaten fresh	June–August	–

Myrica esculenta Buch.-Ham. ex D. Don Myricaceae, tree	Kafal (Np.)	Ripe fruits edible	March–June	–
Nephrolepis cordifolia (L.) C. Presl Davalliaceae, herb	Pani amala (Np.)	Tuberous roots eaten as fruit	August–September	–
Ocimum gratissimum L. Lamiaceae, Herb	Ban tulsi (Bk.)	Seeds edible	October–December	–
Ophioglossum reticulatum L. Ophioglossaceae, herb	Jibre saag (Np.); Ek patiya (Thr.)	Young leaves used as vegetable	March–April	–
Perilla frutescens (L.) Britton Lamiaceae, herb	Silam (Np., Bk.)	Roasted seeds used to make pickle	October–December	–
Phoenix humilis Royle & Hook.f. Palmae, herb	Thakal (Np.); Khajuri (Thr.)	Ripe fruits edible. Tuberous roots eaten as vegetable	February–May	Leaves used as thatching material and as brooms. Fruits used in local liquor preparation
Phyllanthus emblica L. Euphorbiaceae, tree	Amala (Np.); Amar, Aura, Amalosa (Thr.)	Fruits eaten fresh or used to make pickle	October–December	Fruit paste used as fish poisoning. Fruits used in cough and cold
Piper longum L. Piperaceae, herb	Pipla (Np.)	Fruits edible	November–December	Fruit powder used to treat cough and cold
Remusatia vivipara (Roxb.) Schott Araceae, Herb	Jaluko (Np., Thr.)	Tender shoots eaten as vegetable	May–September	–
Rhus javanica Miller Anacardiaceae, Tree	Bhakmilo (Thr.)	Fruits edible	November–March	–
Rhus wallichii Hook.f Anacardiaceae, Tree	Kag bhalayo (Np.)	Fruit pulp eaten	December–April	–
Ricinus communis L. Euphorbiaceae, herb	Ander (Np.); Aril, Raine (Thr.); Renu (Mag.)	Fruits used to make pickle	May–October	Stem used in ear problems

(continued)

Table 6.2 (continued)

Latin name, botanical family, and growth habit	Vernacular name(s)‡	Local use(s) (edible only)	Collection period	Additional local use(s)
Rubus ellipticus Sm.	Aiselu (Np.)	Ripe fruits eaten fresh	May–July	Root juice used to treat typhoid and measles
Rosaceae, shrub				
Schleichera oleosa (Lour.) Merr.	Kusum (Np.); Kosam (Thr.)	Pulp of ripe fruits edible	June–August	Twigs used as fodder. Leaves used as fertilizer
Sapindaceae, tree				
Semecarpus anacardium L.f.	Bhalayo (Np.); Bhella, Bheli (Thr.)	Fruits edible	November–March	Seeds used to cure cut and wounds
Anacardiaceae, tree				
Smilax aspera L.	Kukurdaino (Np.)	Young shoots used as vegetable. Flowers used to make pickle	September–October	–
Smilacaceae, climber				
Smilax ovalifolia Roxb. ex D. Don	Kukurdaino (Np.)	Young shoots used as vegetable	September–October	–
Smilacaceae, climber				
Spondias pinnata (L. f.) Kurz	Amora (Np.); Amar (Thr.)	Fruits edible and also used to make pickle	November–March	–
Anacardiaceae, tree				
Sterculia villosa Roxb.	Odal (Np.)	Fruits edible	June–August	Bark fiber used to make ropes. Root power used as soda powder
Malvaceae, tree				
Symplocos pyrifolia Wall. ex G. Don	Kale kath (Np., Bk.)	Fruits edible	July–August	–
Symplocaceae, tree				
Syzygium cumini (L.) Skeels	Jamun (Np.); Jamuni (Thr.)	Ripe fruits eaten fresh	May–August	Bark juice used in abdominal pain, diarrhea, and as fish poison
Myrtaceae, tree				
Tamilnadia uliginosa (Retz.) Tirveng. & Sastre	Perra (Thr.)	Fruits used as vegetable	May–September	–
Rubiaceae, tree				

Tectaria coadunata (Wall. ex Hook. & Grev.) C. Chr. Dryopteridaceae, herb	Kalo neuro (Np.); Dhakurok (Mag.)	Young leafy parts used as vegetable	May–June	Root juice used in blood dysentery and "Gano"
Tectaria zeylanica (Houtt.) Sledge Ophioglossaceae, Herb	Mayur kutea (Np.); Dhagrajawa (Thr.)	Leaves eaten as vegetable	March–April	–
Terminalia bellerica (Gaertn.) Roxb. Combretaceae, tree	Barro (Np.); Bahare (Thr.)	Seed pulp edible	November–January	Fruits used to prepare local wine. Fruit powder used in cough. Leaves used as plates
Termitomyces eurhizus (Berk.) Heim. Tricholomataceae, Fungi	Chyau (Np., Bk.)	Plant eaten as vegetable	June–September	–
Tetrastigma serrulatum (Roxb.) Planch Vitaceae, climber	Pureni, Charchare jhar (Np.)	Ripe fruits eaten fresh	November–February	Root juice used to treat wounds. Plant juice used in eye troubles. Leaves used as fodder
Urtica dioica L. Urticaceae, herb	Sisnu (Np.)	Young shoots taken as vegetable	Whole year	–
Zizyphus mauritiana Lam. Rhamnaceae, shrub	Bayer (Np.)	Fruits eaten raw or used to make pickle	October–March	Bark juice and stem nodule used in dysentery. Roots used to make fermenting material. Fruit paste used as fish poisoning
Zizyphus rugosa Lam. Rhamnaceae, tree	Rukh bayer (Np.)	Fruits edible	December–February	Stem juice used to treat swelling legs. Fruit paste used as fish poisoning

(continue)

6.3 Wild edible plant studies for Takht-e-Sulaiman Hills, Northwest Pakistan

Botanical taxon	Folk name	Used part(s)	Gathering period	Gathering area(s)	Collectors	Folk food uses	Citation frequency	Previously reported from Pakistan as WFPs
Aerva javanica (Burm.f.) Juss. ex Schult. (127216) Amaranthaceae	Sparokai	Leaves	April–July	Wasteland	Women	Young fresh leaves are boiled in water for ½ h. The extra water is poured out, and the leaves are moved to another container containing ghee with fried onions and red chilies. Kept on the fire until water is evaporated and ghee appears on top. This is then eaten with bread	0.16	Yes
Allium carolinianum DC. (127194) Amaryllidaceae	Khokhai	Whole plant	June–September	Ridges	Men	The leaves and bulbs are eaten with bread	0.37	Yes
Allium sp. Linn. (127217) Amaryllidaceae	Cook	Whole plant	June–September	Slopes and ridges	Men	The leaves and bulbs are eaten with bread and are also used as spice in curry	0.50	Yes
Amaranthus spinosus L. (127219) Amaranthaceae	Sarmay	Leaves	April–July	Wasteland	Women	Young fresh leaves are boiled in water for ½ h. The extra water is poured out, and then the leaves are moved to another container containing ghee with fried onions and red chilies. Kept on the fire until water is evaporated and ghee appears on top. This is then eaten with bread	0.93	Yes

Berberis calliobotrys Bien. ex Koehne (127222)	Sarmay	Fruits	October	Pine forests	Men	Directly consumed	0.11	No
Berberidaceae								
Caragana ambigua Stocks (127205)	Zaray	Flowers	June	Valleys	Kids	Directly consumed	0.02	No
Fabaceae								
Caralluma tuberculata N.E.Br. (127133)	Pamanai	Stems	March–April	Moist shady places	Women, men, kids	Extensive salt is rubbed on the cut pieces and left for half an hour. They are then washed with water. Now, they are fried in hot boiling ghee containing fried onions. This is then eaten with bread	0.22	Yes
Apocynaceae								
Celtis australis L. (127176)	Thaghah	Fruits	May	Near human settlements	Men, kids	Directly consumed	0.05	Yes
Cannabaceae								
Cicer nuristanicum Kitam. (127183)	Chenrah	Fruit	July	High mountain valleys	Kids	Directly consumed	0.06	No
Fabaceae								
Cirsium arvense (L.) Scop. (127231)	Da khwarak azghai	Stems	May–August	Wasteland	Men, kids	The ectoderm of the semi-mature stem is removed. The remaining white fleshy part is eaten raw	0.06	No
Asteraceae								
Cotoneaster microphyllus Wall. Ex Lindl. (127234)	Manray	Fruit	May	Bushy vegetation	Men, kids	Directly consumed	0.30	Yes
Rosaceae								

(continued)

Table 6.3 (continued)

Botanical taxon	Folk name	Used part(s)	Gathering period	Gathering area(s)	Collectors	Folk food uses	Citation frequency	Previously reported from Pakistan as WFPs
Cotoneaster minutus Klotz (127125)	Sharavo	Fruit	September	Shrubby mountain vegetation	Men, kids	Directly consumed	0.59	Yes
Rosaceae								
Cotoneaster pruinosus Klotz (127206)	Pushthawergai	Fruit	August	Beside pedestrian passes	Kids	Directly consumed	0.22	No
Rosaceae								
Cynoglossum lanceolatum Forssk. (127212)	Jezgai	Leaves	April–July	Wasteland	Women	Young fresh leaves are boiled in water for ½ h. The extra water is poured out and then the leaves are moved to another container containing ghee with fried onions and red chilies. Kept on the fire until water is evaporated and ghee appears on top. This is then eaten with bread	0.01	No
Boraginaceae								
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood (127143)	Mermandai	Fruit	May	High mountain valleys	Men, kids	Directly consumed	0.19	Yes
Urticaceae								
Ficus palmata Forssk. (127240)	Injar	Leaves, Fruit	April (Leaves), July (Fruit)	Near human settlements	Women, men, kids	The fruits are directly consumed. The young fresh leaves are boiled in water for 2 h to soften completely. This is then eaten directly or sometimes with bread	0.69	Yes
Moraceae								

Grewia tenax (Forssk.) Fiori (127126)	Pasthawnai	Fruit	August	Hedgerows	Kids	Directly consumed	0.01	Yes
Malvaceae								
Grewia villosa Willd. (127243)	Injarai	Fruit	July	Marshy and bushy vegetation	Kids	Directly consumed	0.08	Yes
Malvaceae								
Lactuca dissecta D.Don (127184)	Paywerka	Leaves	April–August	Hedgerows	Kids	Directly consumed	0.05	No
Asteraceae								
Launaea procumbens (Roxb.) Ramayya & Rajagopal (127180)	Sondrashi	Leaves	April–August	Wasteland	Men, Kids	Directly consumed	0.12	Yes
Asteraceae								
Limonium cabulicum (Boiss.) Kuntze (127170)	Botyarai	Leaves	June–August	Rocky barren land	Men	The fresh leaves are boiled in water containing sugar. This is then taken as tea	0.05	No
Plumbaginaceae								
Malva sylvestris L. (127123)	Methrai	Leaves	April–July	Wasteland	Women	Young fresh leaves are boiled in water for ½ h. The extra water is poured out, and then the leaves are moved to another container containing ghee with fried onions and red chilies. Kept on the fire until water is evaporated and ghee appears on top. This is then eaten with bread	0.08	Yes
Malvaceae								

(continued)

Table 6.3 (continued)

Botanical taxon	Folk name	Used part(s)	Gathering period	Gathering area(s)	Collectors	Folk food uses	Citation frequency	Previously reported from Pakistan as WFPs
Notholirion thomsonianum (Royle) Stapf (127166)	Shyajey	Leaves	April–May	Sandy fertile places	Women, men	Young fresh leaves are boiled in water for ½ h. The extra water is poured out, and then the leaves are moved to another container containing ghee with fried onions and red chilies. Kept on the fire until water is evaporated and ghee appears on top. This is then eaten with bread	0.31	No
Liliaceae								
Olea ferruginea Wall. ex Aitch. (127151)	Shwawan	Fruit, leaves	September	Forests	Women, men, kids	The fruits are directly consumed while the fresh leaves are used as tea	1.0	Yes
Oleaceae								
Oxalis corniculata L. (127198)	Therwashka	Leaves	May	Wasteland	Kids	Directly consumed	0.06	Yes
Oxalidaceae								
Periploca aphylla Decne. (127156)	Barrarr	Fruit and young stems	May	Wasteland	Kids	The fresh green fruits and young stems are chewed and the sweet tasting sap is swallowed	0.06	Yes
Apocynaceae								
Periploca hydaspidis Falc. (127128)	Khwaza waley	Fruit	May	Barren land	Kids	Directly consumed	0.01	Yes
Apocynaceae								
Physalis divaricata D. Don (127181)	Band malkhovj	Fruit	August	Wasteland	Kids	Directly consumed	0.01	No
Solanaceae								

Pinus gerardiana Wall. ex D.Don (127203)	Zanghozai	Fruit	October	Pine forests	Men, kids	Directly consumed	0.59	Yes
Pinaceae								
Pinus wallichiana A.B.Jacks. (127213)	Nashtar	Fruit	October	Pine forests	Men, kids	Directly consumed	0.29	Yes
Pinaceae								
Pistacia chinensis Bunge (127191)	Shrawan	Fruit	October	Forests	Women, men, kids	Directly consumed	0.30	Yes
Anacardiaceae								
Pistacia khinjuk Stocks (127259)	Saho shrawan	Fruit	October	Forests	Men, kids	Directly consumed	0.01	Yes
Anacardiaceae								
Portulaca quadrifida L. (127257)	Pakharai	Aerial parts	May–July	Wasteland	Women	Young fresh leaves including young shoots are boiled in water for ½ h. The extra water is poured out, and then the leaves are moved to another container containing ghee with fried onions and red chilies. Kept on the fire until water is evaporated and ghee appears on top. This is then eaten with bread	0.04	Yes
Portulacaceae								
Punica granatum L. (127208)	Nargos	Fruit	September	Mountains and home gardens	Women, men, kids	Directly consumed	0.55	Yes
Lythraceae								
Pyracantha M. Roam (127127)	Khra sharavo	Fruit	September	Mountain forests	Men, kids	Directly consumed	0.01	Yes
Rosaceae								

(continue)

Table 6.3 (continued)

Botanical taxon	Folk name	Used part(s)	Gathering period	Gathering area(s)	Collectors	Folk food uses	Citation frequency	Previously reported from Pakistan as WFPs
Ribes alpestre Wall. ex Decne. (127193)	Sheen korai	Fruit	July	Bushy vegetation	Kids	Directly consumed	0.01	Yes
Grossulariaceae								
Rosa moschata Herrm. (127134)	Khorach	Fruit	August	High mountain valleys	Men, kids	Directly consumed	0.33	Yes
Rosaceae								
Rubus ulmifolius Schott (127197)	Gharangavo	Fruit	August	Fertile mountain valleys	Men, kids	Directly consumed	0.26	Yes
Rosaceae								
Salvia moorcroftiana Wall. ex Benth. (127131)	Dersai	Stem	May–June	Wasteland	Women, men, kids	The external green part of the semi-matured stem is removed and the remaining white juicy part is eaten raw	0.47	No
Lamiaceae								
Sideroxylon mascatense (A.DC.) T.D.Penn. (127185)	Guargur	Fruit	June	Lowland forests	Women, men, kids	Directly consumed	0.55	Yes
Sapotaceae								
Solanum americanum Mill. (127158)	Malkhovj	Fruit	June	Wasteland	Kids	Directly consumed	0.09	Yes
Solanaceae								
Spiraea canescens D.Don (127265)	Sra wany	Fruit, stem, bark	May	Sloppy and shrubby vegetation	Men, kids	The fruits are directly consumed. The green stem cortex is boiled in water with sugar which is then taken as tea	0.12	Yes (fruit), No (tea)
Rosaceae								

Thymus linearis Benth. (127211)	Marveiy	Leaves	June–September	Waste land	Women, men, kids	The leaves are used as herbal tea	0.09	Yes
Lamiaceae								
Tragopogon gracilis D.Don (127167)	Shabey	Aerial parts	July	Fertile valley bottoms	Kids	Directly consumed	0.12	No
Asteraceae								
Tulipa lehmanniana Merckl. (127148)	Sondai	Bulb	April–June	Mountain plateaus	Men, kids	Directly consumed	0.27	Yes
Liliaceae								
Viburnum cotinifolium D. Don (127210)	Thorayi	Fruit	August	Mountain forests	Women, men, kids	Directly consumed	0.56	Yes
Adoxaceae								
Viscum cruciatum Sieber ex Boiss. (127269)	Da shwawna Lewanai	Leaves	May	Parasite of olive trees	Women, men	The leaves are used as tea	0.11	No
Santalaceae								
Vitis flexuosa Thunb. (127270)	Malavo	Fruit	June	Hedgerows	Women, men, kids	Directly consumed	0.02	Yes
Vitaceae								
Ziziphus jujuba Mill. (127153)	Bera	Fruit	July	Lowland plains	Men, kids	Directly consumed	0.13	Yes
Rhamnaceae								
Ziziphus nummularia (Burm.f.) Wight & Arn. (127271)	Karkanr	Fruit	July	Low land plains	Kids	Directly consumed	0.01	Yes
Rhamnaceae								
Ziziphus oxyphylla Edgew. (127199)	Heilaneiy	Fruit	July	Forests	Women, men, kids	Directly consumed	0.28	

Chapter 7
A Pictorial Guide to Edible Wild Plants

Fig. 7.1 Chitra

Fig. 7.2 Blackberries

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Fig. 7.3 Common quince

Fig. 7.4 Clover

Fig. 7.5 *Daphne*

Fig. 7.6 Dandelion

Fig. 7.7 Wild rhea

Fig. 7.8 Kudzu

Fig. 7.9 Cluster fig tree

Fig. 7.10 Pine

Fig. 7.11 Himalayan strawberry

Fig. 7.12 Plantain

Fig. 7.13 African boxwood

Fig. 7.14 Prickly pear cactus

Fig. 7.15 Creeping wood sorrel

Fig. 7.16 Wild onions

Fig. 7.17 Spogel seed

Fig. 7.18 Elder berries

Fig. 7.19 Wild peach

Fig. 7.20 Wild pomegranate

Fig. 7.21 *Asparagus*

Fig. 7.22 Mulberries

Fig. 7.23 Gooseberries

Fig. 7.24 Daylily

Fig. 7.25 Hazelnuts

Fig. 7.26 Walnuts

Fig. 7.27 Red clover

Fig. 7.28 Chicory

Fig. 7.29 Creeping Charlie

Fig. 7.30 Garlic mustard

Fig. 7.31 Chickweed

Fig. 7.32 Hop clover

Fig. 7.33 Goose tongue

Fig. 7.34 Pigweed

Fig. 7.35 Fireweed

Fig. 7.36 Selfheal

Fig. 7.37 Chinese sweet plum

Fig. 7.38 Makko

Fig. 7.39 Yellow-berried nightshade

Fig. 7.40 Himalayan viburnum

Chapter 8
Conservation Measures and Sustainable Production of Edible Wild Plants

8.1 A Historic Outline About Using Wild Edible Plants

Man started to collect plants before they cultivate them, and by trial and error method, over a thousand years, our ancestors learn which plants to eat and which plants are suitable for cultivation. Then by that time, man selected a few plants and started their domestication. These are only a small fraction of species that bears a heavy burden of food security. Only 20 plants are fulfilling our 90% demand of food and 60% of our caloric demands covered by only 4 plants, i.e., corn, rice, wheat, and soy. It is really surprising that more than 8000 plants in the wild are edible, and we are still using only a fraction of them. The reason behind this is probably we are no longer giving value to our traditional knowledge, and even most of the knowledge is undocumented. These factors trigger the threat to the traditional knowledge about plants whether about their edibility or medicinal use.

Another factor which reinforces the less utilization of wild edible plants is their availability and cheapness. It seems to be shocking and unusual that being cheap and accessible work as their drawback in their popularity. This is because we have divided our societies into different social statuses, and people who categorized themselves as high social class are reluctant to eat that food which is comparatively cheap and available locally. This so-called high class society would more likely to eat those vegetables which are more expensive and imported from other regions of the world, and this is all just to satisfy their useless egos of being rich and wealthy. In contrast farmers and poor people more likely eat those plant species which are abundant and cause no cost for collection. So by that time, eating wild plant has become a symbol of low social status. When these farmers started to move cities or urbanization took place in their rural area, they started to adapt themselves with the urban lifestyle. They changed their food habits, and from wild edible plants, they shifted their diet to the routine cultivated plants. Through this transition the use of wild plants for eating becomes more vague and less frequent.

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Moreover, the urbanization process is in great speed, and because of this, people are leaving those old skills which are used to survive in the countryside. This trend is spreading at a faster rate, and we are forgetting about all those nutritious plants which help us to survive on this planet thousands of years ago. The key example is *Urtica dioica* (stinging nettle) which has higher content of vitamin C than orange, more calcium than cheese, three times more iron than spinach, and proteins comparable to soya bean.

Still in this modern era, some countries have still this worthwhile knowledge of edible plants in their rural areas. It is the prime goal of modern ethnobotany to document and preserve that knowledge.

8.2 A Relationship Between Wild Edible Plants and Current Rural Societies

Still in rural areas around the world, the wild edible plants are eaten by the local communities. However, dependence upon wild edible plants is more common in those areas where less cultivated land is available. Certain wild species are more preferred by others because of their good taste, health value, palatability, ease in availability, or less processing time, though the local people could also eat the non-preferred ones when the preferred species become scarce or rare. It has been observed that even in rural areas, the poorer people showed more dependence on wild edible plants rather than the rich ones. However, during agricultural crop loss, both rich and poor societies showed their dependence on them. Knowledge about these wild edible plants is most commonly kept by the aged people of the society and especially by women, but by the time, this knowledge is becoming ambiguous because of a number of reasons:

- Increasing faith on store-based foods.
- Replacement of traditional training with school education.
- Loss of undocumented data about the wild edible plants.
- Migration of young blood to urban areas in search of better livelihoods.
- Awareness limited to only elderly people. It is not passing heart by heart to the next generation.
- Changing work habits of women also affecting the behavior toward wild edible plants. Now women are working for alternative resource to earn for their families, so they have less or no time to spend in search of wild edible plants. In their busy routine, they prefer more to pick food from stores rather than go in the wild.
- A modification in agricultural and land utilization policy development of infrastructure and commercialization has altered the approach of land usage. Availability of more markets is influencing the interest in wild edible plants.
- Because of the urbanization, now the roads are constructed along the lands where wild edible plants could be found, and this invites a wide range of invasive species to grow among them and compete with them for resources.

Wild edible plant use is like an additional active link with the immediate habitat and a root of culture, not just food and revenue. Therefore, the weakening of traditional habits of life and reduced use of wild edible plants are interwoven.

8.3 Challenges in Incorporating the WEPs into Our Diet

There are definitely not very easy ways to incorporate wild edible plants into our daily diet in a short time. It has to face many challenges in promotion, and some of them are discussed below:

- **Less documented traditional knowledge**
  There are less records or documentation available regarding these wild edible plants. The keys of their identification, management, and processing is not well defined by the available literature.
- **Sustainability**
  We have to be sure that these food are sustainable and sufficiently abundant that they can fulfill the growing market demand. Right now there are insufficient management plans which can assure their sustainable harvesting.
- **Less scientific evaluation of wild edible plants**
  Although the trend of scientific research regarding wild plants has been increased in the last decade, it has not sufficiently provided evidences to support the nutritional and pharmaceutical significance of these plants.
- **Ownership issue**
  The indigenous people who kept the knowledge about these wild edible plants are not willing to share their knowledge with others without having some incentives. Even sometimes, incentives do not attract them to reveal this traditional knowledge. In that case it will become more difficult to make them understand about the benefits of sharing this data.
- **Lack of agronomic data about wild edible plants**
  There is less agronomic studies about these wild edible plants. We certainly do not know what type of agricultural conditions they want to grow. And without having the agronomic data, we cannot harvest them.
- **Lack of governmental support**
  The government and political parties are interested in other methods to raise food security. This way of having alternative edible plants do not really attract them, and they do not want to spend their resources to search and incorporate alternative wild edible plants in the agricultural system.
- **Difficulties in endorsement of wild edible plants**
  As we have less documented traditional and scientific data about these wild edible plants, building up the confidence of customers on them is quite difficult.

Usually people are reluctant for any change. They do not want to alter their taste buds just to ensure the food security.

- **Unawareness about wild edible plants of your own regions**
  As people do not have data, they are not interested in changing their food habits, so they are not interested at all to search for wild edible plants which could be available in their region. They remain unconscious about the wild food wealth they have.
- **Conflict of interest**
  As these plants grow in the wild, there could be a long chain of conflict of interest in their collection, utilization, and marketing.
- **Threat for overexploitation**
  There is threat to maintain the balance between the commercialization of wild edible plants and the threat of their exploitation.
- **Limited market**
  As wild edible plants did not yet gain the people's confidence, there is very limited market for them. Usually, superstores would not likely have them in their food items unless people demand for them.
- **Safety concerns**
  Hence, there is less valid data about the safety concerns of these wild edible plants, so people do not trust them for eating unless they are sure about their health and safety.

8.4 Required Initiatives in Regard to Wild Edible Plants

The following are the proposed steps needed to be taken in order to incorporate the wild edible plants in our food system.

Development of Policies and Strategies

- Endorse intellectual property rights through improved documentation and proof.
- Broadcast sustainable management plans for wild edible plants.
- Develop a system to record all available traditional knowledge and practices.
- Promote high-value distinction through geographical clues (diversity of production, defend farmers against dishonest competition).
- Involve policy-makers in sponsoring indigenous wild edible plants. Integrate wild edible plant biodiversity in government policies and packages.
- Scrutinize legal tools to come up with a legal framework on wild indigenous edible plants.
- Offer the local community for harvesting wild edible plants.
- Develop a strategy for wild edible plant use to ensure the sustainable conservation of them.
- Provide incentives to farmers to grow these new species on their land.

- Stimulate the postharvesting and processing technologies.
- Educate the students at school, college, and university level about the value of wild edible plants and traditional knowledge associated with them.
- Development of policies to commercialize them.
- Integrate with NGOs and seek for their help in spreading awareness about underutilized wild edible plants.
- Provide research facilities to identify the group of people who kept traditional knowledge about these plants.
- Give advance scientific research support to ensure the health safety of these plants.
- Make efforts to identify their conservation status in their habitat before their utilization.
- Incorporation of advance propagation techniques for domestication of wild plants.
- Development of wild edible plants database with handy information about their local and scientific names, images in habitat, and information about their agro-ecological zones, edible parts, preparatory methods, and all other relevant information.
- Data about their nutritional contents and for possible side effects.
- Develop several marketing strategies for wild edible plants and consumer awareness about their value.
- Arrange wild edible plant-eating festivals or competitions at local or national levels.
- Organize field workshops so that people could enable themselves to locate and identify edible plants in wild habitat.
- Develop partnerships at intercity or provincial level to share knowledge, information, and research outputs.
- Develop and promote certain IT- or web-based tools for exchange of information about wild edible plants.
- Collect the germplasm of wild edible plants which are under threat.

Bibliography

1. webarchive.nationalarchives.gov.uk (Cabinet Office: Food matters: towards a strategy for the 21st century)
2. www.bbc.com/costoffood (BBC Special Report: the cost of food)
3. www.thelifeyoucansave.org/Global-Hunger (World Food Programme: winning the war on hunger)
4. brownfieldagnews.com/2009/03/25/a-second-green-revolution/ (Bayer cropscience: the second green revolution)
5. www.fao.org/fileadmin/templates/wsfs (FAO: How to feed the world in 2050)
6. ftp://ftp.fao.org/docrep/fao/011/ai480e/ai480e00.pdf (FAO Crop prospects and food situation 2009 (PDF)
7. news.bbc.co.uk/2/hi/africa/7854126.stm (BBC Q&A: Caterpillars ravage Liberia)
8. https://www.nature.com/news/2009/090130/full/news.2009.72.html (Nature: Halting the African armyworm)
9. www.nzdl.org/gsdlmod (Disappearing food: how big are postharvest losses?)
10. https://www.cigionline.org/sites/default/files/the_global_food_crisis.pdf (Julie Scholes' presentation at workshop: food security and sustainability—can we avert a food crisis?)
11. www.fao.org/agriculture/crops/thematic-sitemap/theme/pests/wrdgp/en/ (FAO Wheat Rust Disease Global Programme)
12. https://en.wikipedia.org/wiki/Green_Revolution (Now for the green revolution)
13. www.fao.org/publications/sofi/en/
14. www.who.int/gho/mdg/poverty_hunger/underweight/en/
15. www.thelancet.com/series/maternal-and-child-nutrition
16. www.fao.org/docrep/013/i2050e/i2050e00.htm
17. documents.wfp.org/stellent/groups/public/documents/communications/wfp220221.pdf
18. www.who.int/nutgrowthdb/publications/stunting1990_2020/en/
19. www.thelancet.com/journals/lancet/article/PIIS0140-6736%2807%2961694-8/abstract
20. P. Collier, A. Hoeffler, M. Söderbom, Post Conflict Risks. CSAE WPS/2006–12. Centre for the Study of African Economics, Oxford University, 2006
21. F. De Beer, H. Swanepoel, *Introduction to development studies* (Oxford University Press, New York, 2000)
22. The 2007/08 Agricultural Price Spikes, Causes and Policy Implications
23. "2008: The year of global food crisis". Sundayherald.com. March 8, 2008. Archived from the original on August 22, 2009. Accessed 13 Nov 2011

S. Shaheen et al., *Edible Wild Plants: An alternative approach to food security*,
DOI 10.1007/978-3-319-63037-3

24. "The global grain bubble". Csmonitor.com. January 18, 2008. Accessed 13 Nov 2011
25. James Randerson, science correspondent (2008, March 7). "Food crisis will take hold before climate change, warns chief scientist". The Guardian (UK). Accessed 13 Nov 2011
26. John Vidal, environment editor (2007, November 3). "Global food crisis looms as climate change and fuel shortages bite". The Guardian (UK). Accessed 13 Nov 2011
27. Walsoft (2008, February 22). "Experts: global food shortages could 'Continue for Decades'". Marketoracle.co.uk. Accessed 13 Nov 2011
28. Moya K. Mason, "Has urbanization caused a loss to agricultural land?" Moyak.com. Accessed 13 Nov 2011
29. Jonathan Watts in Beijing (2007, December 5). "Riots and hunger feared as demand for grain sends food costs soaring". The Guardian (UK). Accessed 13 Nov 2011
30. Julian Borger, diplomatic editor (2008, February 26). "Feed the world? We are fighting a losing battle, UN admits". The Guardian (UK). Accessed 13 Nov 2011
31. "World food summit: basic information". Fas.usda.gov. February 22, 2005. Accessed 16 Mar 2011
32. Food and Agriculture Organization (1996, November). "Rome declaration on food security and world food summit plan of action". Accessed 26 Oct 2013
33. Conference on water scarcity in Africa: issues and challenges. Accessed 18 Mar 2013
34. "Coping with water scarcity: challenge of the 21st century" (PDF). Accessed 18 Mar 2013
35. Ian sample in science correspondent (2007, August 30). "Global food crisis looms as climate change and population growth strip fertile land". The Guardian (UK). Accessed 13 Nov 13
36. "Africa may be able to feed only 25% of its population by 2025". News.mongabay.com. Accessed 13 Nov 2011
37. english@peopledaily.com.cn (2007, July 24). "Glaciers melting at alarming speed". People's Daily. Accessed 13 Nov 2011
38. Glaciers are melting faster than expected, UN Reports. ScienceDaily. March 17, 2008. Accessed 13 Nov 2011
39. "Issues in Food Security" (PDF). Accessed 13 Nov 13 2011
40. Loading the Climate Dice July 22, 2012 Paul Krugman
41. Robin McKie; Xan Rice (2007, April 22). "Millions face famine as crop disease rages". The Guardian (UK). Accessed 13 Nov 2011
42. "Billions at risk from wheat super-blight". New Scientist Magazine (2598): 6–7. April 3, 2007. Accessed 19 Apr 2007
43. Joachim von Braun, M.S. Swaminathan, Mark W. Rosegrant, Agriculture, food security, nutrition, and the millennium development goals: Annual Report Essay. IFPRI, 2003. Accessed 11 Nov 2013
44. De Schutter, Olivier (2010, December), "Report submitted by the Special Rapporteur on the right to food" (PDF). United Nations. pp. 1–21. Accessed 22 Oct 2013
45. FAO, WFP, IFAD. "The State of Food Insecurity in the World 2013. The multiple dimensions of food security." (PDF). FAO. Accessed 26 Nov 2013
46. WFP. "Mission Statement". WFP. Accessed 2 Nov 2013
47. Description and targets for Goal 2 of the Sustainable Development Goals
48. Pope Francis denounces 'global scandal' of hunger. Press release Caritas International, December 2013
49. Compact2025: Ending hunger and undernutrition. 2015. Project Paper. (IFPRI, Washington, DC)
50. European Commission Press release, EU launches new partnership to combat Undernutrition with Bill & Melinda Gates Foundation (2015, June) Accessed 1 Nov 2015
51. Africa's Renewed Partnership to End Hunger by 2025. Accessed 1 Nov 2015
52. USAID—Food Security Archived October 26, 2004, at the Wayback Machine
53. V. Heywood, Use and potential of wild plants in farm households. FAO Farm Systems Management Series. (Food and Agriculture Organisation, Rome, Italy, 1999) [online]. http://www. fao.org/docrep/003/w8801e/w8801e00.htm

54. Milleniumosystem Assessment (MEA), Current state and trends (Washington, DC, 2005)
55. P.J. Ericksen, J.S.I. Ingram, D.M. Liverman, Food security and global environmental change. Environ. Sci. Policy **12**, 373–377 (2009). doi:10.1016/j.envsci.2009.04.007
56. L.E. Grivetti, B.M. Ogle, Value of traditional foods in meeting macro- and micronutrient needs: the wild plant connection. Nutr. Res. Rev **13**, 31–46 (2000)
57. F. Mazhar, D. Buckles, P.V. Satheesh, F. Akhter, *Food sovereignty and uncultivated biodiversity in South Asia* (Academic Foundation, New Delhi, India, 2007)
58. S.E. Pilgrim, L.C. Cullen, D.J. Smith, J. Pretty, Ecological knowledge is lost in wealthier communities and countries. Environ Sci Technol. **42**(4), 1004–1009 (2008)
59. B. Burlingame, Wild Nutrition. Journal of Food Composition and Analysis **13**(2), 99–100 (2000)
60. "Food Security in the U.S.: Measurement." United States Department of Agriculture Economic Research Service. U.S. Department of Agriculture, 8 Sept. 2015. http://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/measurement.aspx#security. Accessed 9 Nov 2015
61. Current and Prospective Scope of Hunger and Food Security in America: A Review of Current Research. Research Triangle Park: RTI International, 2014. RTI International. http://www.rti.org/pubs/full_hunger_report_final_07-24-14.pdf. Accessed 30 Nov 2015